

# Association between Health Care Utilization with Asthma Control Levels among a Sample of Adult Patients in Puerto Rico

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**Objective:** Asthma is an important and serious public health problem in Puerto Rico; however, very few studies measuring the association between health care utilization and asthma control levels in adult asthma patients in Puerto Rico have been done.

**Methods:** This study is secondary analysis of an observational and cross-sectional database generated by the Latin American Asthma Insights and Management (LA AIM) survey. Our sub-sample consisted of adults 18 years or older living with asthma, representing a total of 343 individuals. This study determined the numbers of ambulatory physician visits, emergency visits to a physician or an emergency room, and hospitalizations that took place the 12 months prior to the survey. Patients were characterized as having well-controlled, partly controlled, or uncontrolled asthma. Descriptive and inferential statistics were performed to detect differences in the mean and number of events for physician visits, emergency visits, and hospitalizations by asthma control groups.

**Results:** After adjusting for age, sex, and chronic health conditions (other than asthma), adult asthma patients with controlled asthma had 92.0% fewer physician visits, 82.5% fewer emergency visits, and 92.2% fewer hospitalizations than did those with uncontrolled asthma.

**Conclusion:** Interventions geared toward controlling asthma symptoms and clinical manifestations in adults asthma patients—which interventions might include strategies for controlling environmental risk factors, increasing patient and family education with regard to asthma management, and boosting the use of appropriate and effective medications—may have significant potential in terms of reducing the direct and indirect costs of asthma, costs that have a critical impact on the whole health care system. [*PR Health Sci J* 2016;35:81-87]

*Key words:* Adult asthma patients, Controlled asthma, Uncontrolled asthma, Emergency room use, Hospitalizations

It has been recognized that asthma is an important and serious public health problem in Puerto Rico in terms of its prevalence, morbidity and mortality (1–5). In 2012, the Puerto Rico Asthma Project (PRAP) reported that the current prevalence of asthma was 13.7% among children ( $\leq 17$  years) and 8.9% among adults ( $> 17$  years) (6). Moreover, in 2005 the current prevalence rate among children was 16.7% in Puerto Rico versus 9.0% in the United States, and despite a decreasing trend, in 2010 the rates were still relatively high, being 12.2% in Puerto Rico and 8.4% in the US (7). Furthermore, asthma mortality rates adjusted for age were 1.7 to 4.0 times higher on the island than in the United States for the period of 1980 to 2007 (8). As a result, in recent years, numerous epidemiological and health services studies, particularly on pediatric asthma patients in Puerto Rico, have come out (9–23).

Given that asthma is a chronic disease that usually manifests in early childhood and for which so far no cure is available, controlling the clinical manifestations of the condition becomes one of the most feasible and effective therapeutic strategies.

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Therefore, the measure of the association between the social burden of asthma and the levels of asthma control that asthma patients have achieved turns out to be a very important piece of information for policymakers, health care providers and payers, and patients in terms of guiding the decision-making process to be implemented in developing effective strategies to reduce the burden of asthma in Puerto Rico. In this area, however, our knowledge is incomplete because very few studies have been done measuring the burden of asthma in the Puerto Rican adult population, and even fewer measuring the association between that burden and levels of asthma control (1, 2, 4, 5, 24).

This study provides a unique opportunity to start filling the gap in the knowledge and understanding of the association between asthma control levels and the utilization of health care services by adults in Puerto Rico who suffer from asthma. We used a sub-sample of 343 adult patients (18 years old and older) from the Latin American Asthma Insight Management (LA AIM) survey, implemented in Puerto Rico in 2011, to test the hypothesis that relatively higher levels of asthma control, according to the Global Initiative for Asthma (GINA) criteria (25), are associated with reductions in the utilization of health services. Based on the evidence we will present next, we assert that the previous hypothesis is true, which, restated, is that relatively higher levels of asthma control in the adult population are associated with decreases in the utilization of health care services associated with asthma symptoms. This hypothesis provides further justification for the need to increase resources, services, and programs geared toward increasing the management of asthma by reducing environmental risk factors, increasing patient and family education with regard to asthma management, and boosting the use of appropriate and effective medications.

## Methods

### Design and Sampling

In this study a secondary analysis was performed using an observational and cross-sectional database generated by the Latin American Asthma Insights and Management (LA AIM) survey conducted in 2011, which was commissioned by Merck Sharp and Dohme (MSD) and conducted in various parts of the world (26, 27). The LA AIM included 2,168 asthma patients who were 12 years old or older and who were identified in 51,208 households selected from urban areas in Argentina, Brazil, Mexico, Puerto Rico, and Venezuela. Within each country, participants were selected using national probability sampling; there was no stratification employed within the sampled areas. Each household selected in the sample areas was contacted, and if someone within the household reported having been diagnosed with asthma and either currently taking asthma medication or having one or more asthma attacks, experienced asthma symptoms, or both in the previous year, the household was included in the study. If no one had asthma, the household was screened out and the interviewers moved on to the next house. All interviews were conducted in person.

The total number of households sampled in Puerto Rico was 2,193, from which were interviewed 401 individuals from the following highly densely populated municipalities of the island: San Juan (107), Bayamon (56), Carolina (48), Ponce (48), Caguas (40), Arecibo (30), Mayaguez (24), Trujillo Alto (24), Guaynabo (18), and Cataño (6). The interviews averaged 35 minutes in length, and for subjects aged from 12 to 17 years, the survey was completed by a parent/guardian; subjects under 12 years of age were excluded from the sample. For the purpose of this study, our sub-sample consisted of adult 18 years or older living with asthma representing a total of 343 individuals.

### Instruments

The LA AIM survey was developed by Abt SRBI (New York, USA) and was generally designed to follow the methods used in the Asthma Insight Management (AIM) surveys conducted previously in the US, Canada, Europe, and the Asia Pacific Region (28–31), but only from the patient perspective. The survey includes questions about the following topics: the impact of asthma on the patient's activities, lifestyle, and work productivity; the emotional burden of the condition; defining and characterizing symptoms; the influences of seasons on symptoms; triggers; most bothersome symptoms; and the patient's perceptions about his or her current levels of control. The time frames of the questions included lifetime events, events in the last 12 months, events in the last 4 weeks, and current events (with respect to the moment when the interview took place).

### Variables

The principal outcome for this study is the number of ambulatory physician visits, emergency visits to a physician or emergency room (ER), and hospitalizations all having taken in the last 12 months prior to the survey. All of these events were related to asthma symptoms and were self-reported by the patient. Patients were characterized based on the Global Initiative for Asthma (GINA) guidelines (25, 32) as having well-controlled, partly controlled, or uncontrolled asthma over the previous 4 weeks (Table 1). The manifestations of asthma used for the categorizations included daytime symptoms, the restriction of daily activities, nighttime symptoms, and the need for reliever/rescue treatment. Any patient whose survey was lacking one or more answers about symptoms was considered as not having the symptom or symptoms in question; when this was the case, responses from other domains were used to determine that individual's level of asthma control. Obviously, a classification error could be introduced because some patients could be misclassified as being part of the controlled or partially controlled groups when they were really part of the uncontrolled group. As a result, our final results could be underestimating the magnitude of the differences in health care utilization between the asthma control groups. However, this potential bias does not undermine the internal or external validity of our study in any significant manner.

The following additional variables were included in this study for the purpose of describing the sample and were used as confounders in the multivariate statistical analyses: gender, age, and number of chronic conditions other than asthma. Variables were operationalized in the following manner: health care-utilization variables were used as discrete variables (0, 1, 2, 3, . . .); the frequency of asthma symptoms, GINA asthma control status, years of age, and number of chronic conditions other than asthma were used as ordinal categorical variables; and gender was defined as a qualitative categorical variable. Specifically, the GINA asthma control status was divided into 3 levels (controlled, partly controlled, and uncontrolled asthma), gender into 2 categories (male and female), years of age into 3 levels (18–34, 35–54, and ≥55), and the number of chronic conditions into 4 levels (none, 1 condition, 2 conditions, 3 or more conditions).

**Statistical analyses**

Descriptive and inferential statistics using bivariate and multivariable analyses were performed. In the descriptive analysis, 3 tables were prepared: the absolute and percentage distribution of the 343 adult asthma patients across the different categories, for frequency of asthma symptoms (during the day, at night, and during exercise) and for relief/rescue medication (Table 2); the absolute and percentage distribution for gender, age, and chronic conditions, for the whole sample and by GINA asthma control status group (Table 3); and the distribution of the number of events for physician visits, emergency visits, and hospitalizations, for the total sample and by asthma control group (Table 4).

In the inferential analysis, an analysis of variance (ANOVA) (Table 5) was performed in order to test the differences of the means of the number of health care events across asthma control groups. The last step in the inferential statistical analysis was the multivariate regression analysis in which, for each outcome variable, a negative binomial regression model was estimated (Table 6). A negative binomial regression is a type of generalized linear model in which the dependent variable is a count of the number of times an event occurs, which event usually has a right-skewed distribution (33). The reasons for using a negative binomial regression model were the following: first, different from the Poisson regression model, the negative binomial model is not restricted by the assumption that the mean and variance of the distribution must be the same; and second, through the exponentiation of the regression coefficients, and further mathematical transformation, we were able to estimate the percentage differences in the frequency of events between the

**Table 1.** Control status according to Global Initiative for Asthma (GINA) guidelines

| Characteristic/measurement (assessed for the last 4 weeks) | Controlled (all of the below measures) | Partly controlled (any measure present in any week) | Uncontrolled   |
|--|--|---|--|
| Daytime symptoms   | None (twice or less/week)              | More than twice/week                                | Three or more features of partly controlled asthma present in any week |
| Limitations of activity                                    | None                                   | Any   |  |
| Nocturnal symptoms/awakening                               | None                                   | Any   |  |
| Need of reliever/rescue treatment                          | None                                   | More than twice/week                                |  |
| Lung function (PEF or FEV1)*                               | Normal                                 | <80% predicted or personal best (if known)          |  |
| Exacerbations  | None                                   | ≥1 per year   | 1 in any week  |

\*Without administration of bronchodilator.

**Table 2.** Descriptive statistics for the frequency of asthma symptoms (a cough, wheezing, shortness of breath, or chest tightness) and use of relief/rescue medication in the last 4 weeks (n = 343)

| Symptom/use of medication  | Frequency              | Count | Rel. % |
|--|------------------------|-------|--------|
| Weekly occurrence of asthma symptoms in the last 4 weeks (missing = 8)         | None                   | 121   | 36.1%  |
|  | One per week           | 45    | 13.4%  |
|  | Two per week           | 53    | 15.8%  |
|  | Three per week         | 29    | 8.7%   |
|  | Four per week          | 18    | 5.4%   |
|  | Five per week          | 11    | 3.3%   |
|  | Six per week           | 5     | 1.5%   |
|  | Seven or more per week | 53    | 15.9%  |
| Frequency of asthma symptoms during the day in the last 4 weeks (missing = 1)  | None                   | 137   | 40.1%  |
|  | Every day              | 49    | 14.3%  |
|  | Most days              | 78    | 22.8%  |
|  | At least twice a week  | 40    | 11.7%  |
|  | Once a week            | 14    | 4.1%   |
|  | At least twice a month | 15    | 4.4%   |
| Frequency of asthma symptoms at night in the last 4 weeks (missing = 2)        | None                   | 170   | 49.9%  |
|  | Every night            | 17    | 5.0%   |
|  | Most nights            | 81    | 23.8%  |
|  | At least twice a week  | 43    | 12.6%  |
|  | Once a week            | 12    | 3.5%   |
|  | At least twice a month | 11    | 3.2%   |
| Frequency of asthma symptoms during exercise in the last 4 weeks (missing = 5) | None                   | 199   | 58.9%  |
|  | Every day              | 21    | 6.2%   |
|  | Most days              | 68    | 20.1%  |
|  | At least twice a week  | 30    | 8.9%   |
|  | Once a week            | 11    | 3.3%   |
|  | At least twice a month | 7     | 2.1%   |
| Use of relief or rescue asthma medication in the last 4 weeks (missing = 2)    | Yes                    | 200   | 58.65% |
|  | No                     | 141   | 41.35% |

**Table 3.** Descriptive statistics for the characteristics of the sample of patients living with asthma by GINA asthma control status

| Variable  | Category/level | Total sample | GINA asthma control status |                   |              |
|---|----------------|--------------|----------------------------|-------------------|--------------|
|   |                |              | Controlled                 | Partly controlled | Uncontrolled |
|   | n              | 343          | 22                         | 197               | 124          |
|   | row %          | 100.0%       | 6.4%                       | 57.4%             | 36.2%        |
| Gender  | Male           | 107          | 8                          | 71                | 28           |
|   | col %          | 31.2%        | 36.4%                      | 36.0%             | 22.6%        |
|   | Female         | 236          | 14                         | 126               | 96           |
|   | col %          | 61.8%        | 63.6%                      | 64.0%             | 77.4%        |
| Age group   | 18 to 34       | 114          | 11                         | 66                | 37           |
|   | col %          | 33.2%        | 50.0%                      | 33.5%             | 29.8%        |
|   | 35 to 54       | 91           | 2                          | 59                | 30           |
|   | col %          | 26.5%        | 9.1%                       | 29.9%             | 24.2%        |
|   | ≥55            | 138          | 9                          | 72                | 57           |
|   | col %          | 40.2%        | 40.9%                      | 36.5%             | 46.0%        |
| Number of chronic health conditions other than asthma | None           | 197          | 15                         | 97                | 40           |
|   | col %          | 44.3%        | 68.2%                      | 49.2%             | 32.3%        |
|   | One            | 94           | 2                          | 53                | 39           |
|   | col %          | 24.2%        | 9.1%                       | 23.4%             | 28.2%        |
|   | Two            | 52           | 1                          | 28                | 23           |
|   | col %          | 14.6%        | 4.5%                       | 13.2%             | 18.5%        |
|   | Three or more  | 58           | 4                          | 28                | 26           |
|   | col %          | 16.9%        | 18.2%                      | 14.2%             | 21.0%        |

**Table 4.** Distribution of the total events of health care services used in the last 12 months because of asthma symptoms, by GINA asthma control status

| Type of service | Total sample | GINA asthma control status |                   |              |
|-----------------|--------------|----------------------------|-------------------|--------------|
|                 |              | Controlled                 | Partly controlled | Uncontrolled |
| n               | 343          | 22                         | 197               | 124          |
| row %           | 100.0%       | 6.4%                       | 57.4%             | 36.2%        |
| Physician visit | 1,924        | 14                         | 896               | 1,013        |
| row %           | 100.0%       | 0.7%                       | 46.6%             | 52.6%        |
| Emergency visit | 837          | 10                         | 494               | 331          |
| row %           | 100.0%       | 1.2%                       | 59.1%             | 41.4%        |
| Hospitalization | 295          | 2                          | 89                | 202          |
| row %           | 100.0%       | 0.7%                       | 30.1%             | 68.5%        |

controlled and partly controlled groups versus the uncontrolled group (34). The confounding variables used in the regressions were as follows: a dummy variable for the gender category male (female as the reference group), dummy variables for the age groups (18 to 34 age group as reference), and dummy variables for the number of chronic conditions (0 conditions as reference). An interaction assessment was not performed on the regression analysis because this study was not designed to have enough sample size to adequately assess potential interactions among all the independent variables in the model. All the statistical analyses were performed with GRETLL 1.9.7 (35), and the tables were prepared using Excel.

**Ethical considerations**

In September of 2013, the Institutional Review Board (IRB) of UPR-MSU approved protocol #8770113, titled: The Burden of Asthma in Puerto Rico: Results of the Latin American Insight Management (LA AIM) Survey in Puerto Rico.

**Results**

**Descriptive statistics**

Almost two thirds (64%) of the participating adults reported experiencing (in the 4 weeks prior to being interviewed) 1 or more symptoms of asthma (a cough, wheezing, shortness of breath, or chest tightness) on a weekly basis (Table 2). Around 37% said that every day or most days they experienced asthma symptoms during the day, and 41% said they experienced such symptoms every night, most nights, or at least two nights a week. Furthermore, in the 4 weeks before the interview, 41% of the sample experienced some type of asthma symptom when doing exercise, and

58% had to use some type of rescue/relief medication. Given this morbidity and based on the definition of the GINA Asthma Control Status (Table 1), adults living with asthma were classified in the following categories of asthma control (Table 3): partly controlled (57.4%), uncontrolled (36.2%), and controlled (6.4%).

With respect to the gender distribution, of the 343 patients, almost two thirds were female (61.8%). Of the patients with uncontrolled asthma, the highest proportion was female (77.4%) (Table 3). In terms of the age distribution (Table 3), the largest group of patients consisted of those who were older than 54 years (40.2%); next was the group of individuals who ranged from 18 to 34 years (33.4%), followed by those from 35 to 54 (26.5%). Comparing across groups according to asthma control status, uncontrolled asthma was found in a larger proportion (46.0%) of patients who were older than 54 years of age than was found in the patients in any other age group.

Looking at the number of chronic health conditions other than asthma (Table 3), almost half of the patients (44.3%) reported having none; almost one quarter reported having just 1 condition (24.2%); and a minority reported having either 2 (14.6%) or 3 or more (16.9%) such conditions. Finally, there were more patients whose asthma was controlled and who had no additional chronic conditions (68.2%) than patients whose asthma was either partly controlled or uncontrolled and who had 1 or more additional chronic conditions.

Next, we turn our attention to the outcome variables of interest: the utilization of health care services due to

**Table 5.** Bivariate statistics for the mean number of health care events in the last 12 months because of asthma symptoms, by the GINA asthma control status

| Type of health  | Statistic | Sample | GINA asthma control status |                      |              | p-value for ANOVA test* |
|-----------------|-----------|--------|----------------------------|----------------------|--------------|-------------------------|
|                 |           |        | Controlled                 | Partially controlled | Uncontrolled |                         |
|                 | n         | 343    | 22                         | 197                  | 124          |                         |
| Physician visit | mean      | 5.61   | 0.63                       | 4.55                 | 8.17         | <0.01                   |
|                 | SD        | 0.65   | 0.72                       | 13.10                | 15.70        |                         |
| Emergency visit | mean      | 2.44   | 0.45                       | 2.51                 | 2.67         | <0.01                   |
|                 | SD        | 0.40   | 0.67                       | 10.34                | 4.45         |                         |
| Hospitalization | mean      | 0.86   | 0.09                       | 0.45                 | 1.63         | <0.01                   |
|                 | SD        | 0.19   | 0.29                       | 2.42                 | 5.81         |                         |

Footnotes: \*Given the highly skewed distribution of the health care-service utilization variables and because of the great differences in variances among the asthma control groups, the variables were transformed by taking their natural logs. But since many of the variables have zeros, a one (1) was added to each of the values before taking their natural logs. For example, physician visits (VISITS) was transformed in the following manner: LN(VISITS + 1). By transforming the variables to their natural logs, we reduced their skewedness and variance within the asthma control groups, which allowed us to then perform the ANOVA test.

asthma (Table 4). In the 12 months before the interview, there were a total of 1,924 regular ambulatory physician visits, 295 hospitalizations, and 837 emergency visits to the ER or to physicians, all related to asthma. Members of the controlled group made 0.7% of the physician visits, members of the partly controlled group made 46.6% of the visits, and members of the uncontrolled group made 52.6% of the visits. Patients in the controlled group accounted for 0.7% of the hospitalizations, those in the partly controlled group were responsible for 30.1% of the hospitalizations, and those in the uncontrolled group accounted for 68.5% of the hospitalizations. Finally, 1.2% of the emergency visits were generated by patients in the controlled group, 59.1% by patients in the partly controlled group, and 41.4% by those in the uncontrolled group.

0.63. These differences were large and statistically significant according to the ANOVA test ( $p < 0.01$ ). This was also the case for the mean number of hospitalizations, where the mean for the total sample was less than 1 (0.86) and the means for each group were the following: 1.63 for the uncontrolled group, 0.45 for the partly controlled group, and 0.29 for the controlled group. These differences were large and statistically significant ( $p < 0.05$ ) for the whole sample and for each of the groups. For the number of emergency visits, the mean for the whole sample was 2.44, while the uncontrolled and partly controlled group had very similar means, with 2.67 and 2.51 visits, respectively; however, the controlled group had a mean of only 0.45 visits. These differences were also statistically significant ( $p < 0.01$ ).

After adjusting for gender, age, and chronic health conditions (other than asthma), the results for the negative binomial

**Inferential statistics**

Next, we looked at potentially statistically significant differences in the mean of the frequency of health care events between the asthma control groups. First the variables were transformed by taking their natural logs. By transforming the variables to their natural logs, their skewedness and variance within the asthma control groups were reduced, which allowed us to perform the ANOVA tests. For physician visits in the last 12 months due to asthma, the mean number of visits was 5.61 for the whole sample of 343 patients (Table 5). The uncontrolled group had the highest mean, with 8.17 visits, followed by the partly controlled group, with 4.55, and the controlled group, with

**Table 6.** Results of the negative binomial regressions for the frequency of health care services events in the last 12 months because of asthma symptoms

| Outcome variable | GINA asthma control status | Regression coefficients and statistics <sup>†</sup> |      |        |       |         | Percentage differences in the outcome variable with respect to uncontrolled group <sup>‡</sup> |        |        |  |
|------------------|----------------------------|---|------|--------|-------|---------|--|--------|--------|--|
|                  |                            | β   | SE   | 95% CI |       | p-value | % Diff <sup>(2)</sup>  | 95% CI |        |  |
|                  |                            |   |      | LL     | UL    |         |  | LL     | UL     |  |
| Physician visit  | Uncontrolled               | reference group                                     |      |        |       |         |  |        |        |  |
|                  | Controlled                 | -2.53   | 0.43 | -3.38  | -1.68 | <0.01   | -92.0%   | -96.6% | -81.3% |  |
|                  | Partly controlled          | -0.58   | 0.17 | -0.92  | -0.24 | <0.01   | -43.9%   | -60.1% | -21.3% |  |
| Emergency visit  | Uncontrolled               | reference group                                     |      |        |       |         |  |        |        |  |
|                  | Controlled                 | -1.74   | 0.49 | -2.70  | -0.78 | <0.01   | -82.5%   | -93.3% | -54.1% |  |
|                  | Partly controlled          | -0.34   | 0.21 | -0.75  | 0.06  | 0.09    | -29.2%   | -52.8% | 6.1%   |  |
| Hospitalization  | Uncontrolled               | reference group                                     |      |        |       |         |  |        |        |  |
|                  | Controlled                 | -2.55   | 1.02 | -4.56  | -0.54 | 0.01    | -92.2%   | -99.0% | -41.9% |  |
|                  | Partly controlled          | -1.38   | 0.37 | -2.12  | -0.64 | <0.01   | -74.9%   | -89.1% | -47.3% |  |

Footnotes: <sup>†</sup>Regression coefficients are adjusted for gender, age, number of chronic conditions other than asthma. Coefficients and statistics for these control variables are not reported here because of space limitations but are available upon request. The total sample size of asthma patients in each regression was 343<sup>‡</sup>. The percentage differences in the frequency of events related to each service compared to the uncontrolled group were calculated using the following formula:  $= (e^{\beta} - 1) * 100$ . In the previous expression, beta ( $\beta$ ) is the regression coefficient for each of the variables from the negative binomial regression.

regressions (Table 6) show that the mean percentage difference in physician visits for the control group (compared to the uncontrolled group) was -92.0% (95% CI: -96.6%, -81.3%); for the partly controlled group (also compared to the uncontrolled group), the mean difference was -43.9% (95% CI: -60.1%, -21.3%). For emergency visits, the mean difference for the controlled group was -82.5% (95% CI: -93.3%, -54.1%) and for the partly controlled group, -29.2% (95% CI: -52.8%, 6.1%), both compared to the uncontrolled group. For hospitalizations, the mean difference for the controlled group was -92.2% (95% CI: -99.0%, -41.9%) and for the partly controlled group, -74.9% (95% CI: -89.1%, -47.3%), both again compared to the uncontrolled group. All of the differences were statistically significant ( $p < 0.05$ ) with the exception of the difference for emergency visits between the partly controlled and uncontrolled groups ( $p = 0.09$ ), which was marginally significant.

## Discussion and Conclusions

In summary, the analysis of the LA AIM database for Puerto Rico strongly showed that even after adjusting for some patient characteristics, adults with uncontrolled asthma more frequently used health care services than did their completely or partially controlled counterparts. Therefore, the statistical analyses provides compelling evidence that confirms our hypothesis that there is a strong negative association between levels of asthma control, as defined by GINA, and the frequency of health care-resource consumption related to asthma symptoms. In addition, these results are in agreement with those of other studies (examining children with asthma rather than their adult counterparts) (18, 36, 37) in Puerto Rico and the US, where better asthma control is associated with reductions in the frequency of the utilization of health care services.

These findings are of key importance to policymakers, health care providers and payers, and patients in Puerto Rico and can be used in their efforts to reduce the burden of asthma on the island's health care system. Since other studies have indicated that the largest proportion of emergency room visits and hospitalizations among asthma patients in Puerto Rico correspond to the adult population (2–4, 24), the potential benefits of controlling asthma symptoms would be substantial. For example, assuming that the total population of adult asthma patients in Puerto Rico behaves similarly to the sub-sample of adults from the LA AIM database, we estimate that 70.6% of physicians visits, 52.0% of emergency visits, and 83.2% of hospitalizations related to asthma (and all generated by adult patients) could be eliminated by reducing asthma symptoms among those patients whose asthma is uncontrolled or partially controlled. Therefore, interventions geared toward increasing the management of asthma—reducing environmental risk factors, increasing patient and family education with regard to asthma management, and boosting the use of appropriate and effective medications, among others—may have significant potential in terms of reducing the direct and indirect costs of asthma, all of which costs represent a significant

encumbrance on not only the health care system as a whole but also the individual asthma patient.

Future research efforts that make use of the LA AIM database (specifically, the sample of adult asthma sufferers in Puerto Rico) can be employed in the following tasks: estimating the social burden of asthma and asthma symptoms with respect to health care expenditures and the loss of labor productivity; and determining how (and to what degree) the different levels of asthma control are associated with environmental, sociodemographic, and economic factors as well as with the use of physician services, various medications, and different health therapies and interventions.

Finally, this study has some limitations that we need to recognize. First, there are limitations that are related to the use of the LA AIM survey instrument. No objective clinical data from medical records or other sources were gathered: all the clinical data were obtained from the self-report of the patients surveyed. As is the case with any survey which relies on subjects' self-reports, there are potential biases that can affect the accuracy and reliability of the data reported. Second, this is an observational and cross-sectional study, which implies that the results might have a low internal validity. Third, the results of this study may represent only the subjects in the sample or, at most, adult asthma patients in Puerto Rico who live in densely populated municipalities; this narrowing of focus reduces the external validity of the study. Finally, information on the process of the calibration and validation of the original LA AIM instrument for linguistic and cultural differences was not available to the authors of this study.

## Resumen

**Objetivo:** El asma es un problema de salud pública importante en Puerto Rico, sin embargo, pocos estudios se han hecho midiendo la asociación entre la utilización de servicios de salud y los niveles de control del asma en pacientes adultos en Puerto Rico. **Métodos:** Este estudio es un análisis secundario de una base de datos observacional y transversal generada por la encuesta Latin American Asthma Insights and Management (LA AIM). Los pacientes de 18 años o más ( $n=343$ ) se categorizaron si tenían su asma controlada, controlada parcialmente, o no controlada. Luego, estadísticas descriptivas e inferenciales se estimaron para detectar diferencias en la media y volumen de eventos de las visitas médicas, visitas de emergencia y hospitalizaciones a través de los grupos de control del asma. **Resultados:** Después de ajustar por edad, sexo, y por condiciones crónicas de salud aparte de asma, los pacientes asmáticos adultos con asma controlada tenían 92.0% menos visitas al médico, el 82.5% menos visitas de emergencia, y un 92.2% menos hospitalizaciones que las personas con asma no controlada. **Conclusión:** Las intervenciones dirigidas a controlar los síntomas y manifestaciones clínicas del asma, como por ejemplo, controlar los factores de riesgo ambientales, incrementar la educación y capacitación al paciente y su familia para manejar su condición y el uso de medicamentos apropiados

y eficaces, pueden tener un potencial significativo de reducción de los costos directo e indirectos del asma en el sistema de servicios de salud.

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