National trends in hospital admissions for asthma exacerbations among pediatric and young adult population in Spain (2002–2010)

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KEYWORDS
Asthma exacerbations; Incidence; Cost; Mortality; Outcome research; Spain

Summary
Objective: To assess the changes in incidence, use of mechanical ventilation, length of stay (LOS), costs and mortality of children (0–15 years) and young adults (16–45 years) hospitalized for asthma exacerbations.

Methods: We included patients hospitalized for asthma exacerbations in Spain from 2002 to 2010 (ICD9-CM codes 493.0x–493.9x). The data were collected from the National Hospital Discharge Database (entire population). We calculated the yearly age- and sex-specific incidence rates for each of the two groups.

Results: We included a total of 12,038 pediatric patients and 2792 young adults hospitalized for asthma exacerbations. Overall crude incidence decreased from 20.5 to 18.7 admissions per 100,000 inhabitants in the pediatric group (*p* < 0.05), and from 4.12 to 3.68 admissions per 100,000 inhabitants among young adults, from 2002 to 2010 (*p* < 0.05). By contrast, we detected a significant increase in the use of non-invasive ventilation (NIV) in both groups.

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Background

Asthma, a chronic respiratory disease characterized by episodic airway obstruction, hyper-responsiveness, and inflammation, continues to be a major public health problem throughout the world because of its prevalence and morbidity [1,2]. Around 300 million individuals of all ages worldwide suffer from this disease, which causes 250,000 deaths per year [1]. In Spain, the prevalence of asthma in children aged 6–7 years is 10.7% for boys and 8.2% for girls, and in children aged 13–14 years, the respective rates are 9.3% and 9.2% [3]. On the other hand, approximately 5% of the Spanish adult population has asthma [4,5].

When inappropriately treated, the complications associated with asthma can result in increased exacerbations and hospital admission [6]. Asthma hospitalizations represent a serious adverse outcome that is theoretically preventable with high-quality healthcare, patient education and optimal treatment of asthma [7]. The number and duration of hospitalization, admissions to the ICU and need of mechanical ventilation affect the cost of asthma significantly. In fact, hospitalizations are known to be an important driver of asthma-related direct healthcare costs [7]. Therefore, to improve outcomes, we need to optimize the management of this disease.

Hospital admissions for asthma are one of the best sources of information about trends and prognosis in the morbidity of the disease, but there is no data available in many countries [8]. Collecting data about hospitalizations for asthma exacerbations is important at a country level to evaluate the incidence, patient characteristics and outcome of the hospital admissions in variables such as use of mechanical ventilation, length of stay, mortality and burden of disease. In Spain, there are no recent data on hospital admissions for asthma exacerbations at the national level, neither among pediatric patients neither in adults. However, Gonzalez-Barcala et al. [8] found a significant increase in hospital admissions due to asthma in individuals aged 15 years or above in the Galician region between the years 1995–2009. These data are opposite to those found in most developed countries, where it has been observed a decreasing trend [9]. Comparisons of hospital admissions for asthma exacerbations and outcomes between countries could provide information that would help to understand the possible differences and would also aid for planning the provision of healthcare services. The discharge database provides a large alternative information source to describe and analyze the trends and characteristics of hospitalizations for asthma exacerbations at a national level.

The aim of this study was to analyze national representative hospital discharge data, collected from 2002 to 2010 years, to elucidate changes in the incidence, inpatient healthcare utilization for asthma such us in-hospital use of mechanical ventilation, length of hospital stay (LOS), costs and in-hospital mortality (IHM) of patients (children and young adults) hospitalized for asthma exacerbations in Spain over time.

Methods

A retrospective, descriptive, epidemiology study was conducted using the Spanish National Hospital Database (CMBD, Conjunto Minimo Básico de Datos), which compiles all the public and private hospital data, hence covering more than 95% of hospital discharges. The CMBD database is managed by the Spanish Ministry of Health and Social Policy and Equality and includes patients’ variables (sex, date of birth), date of admittance, date of discharge, up to 14 discharge diagnosis, and up to 20 procedures performed during the admission. The Spanish Ministry of Health and Social Policy and Equality sets standards for registration and performs periodic audits [10].

We selected all admissions of patients who were diagnosed with acute asthma exacerbation as the primary diagnosis using the International Classification Diseases-Ninth Revision, Clinical Modification (ICD-9-CM). Procedure codes used were: 493.0x–493.9x. We analyze pediatric patients (0–15 years) and young adults (16–45 years old) separately. We calculated the yearly age- and sex-specific incidence rates for each of the two groups. The proportion of patients that died during the hospital admissions (IHM), LOS, and costs were also estimated for each year studied. Costs were calculated using Diagnosis-Related Groups (GRD) for the disease. GRD represents a medical-economic entity concerning a set of diseases requiring analogous management resources [11]. All costs shown are adjusted for the increment of the inflation in the same period in Spain.

We analyzed the use of ventilatory support during admissions for acute asthma exacerbations. Use of non-invasive ventilation (NIV) and invasive mechanical ventilation (NIV) and invasive mechanical
ventilation (IMV) was determined based on procedure codes 93.90 and 96.04, respectively. If both procedures were used the patient was included in the IMV group.

**Statistical analysis**

A descriptive statistical analysis was performed. We calculated the yearly age- and sex-specific incidence rates for hospitalizations by acute asthma exacerbation by dividing the number of cases by year, sex, and age group by the corresponding number of people in that population group according to data from the Spanish National Institute of Statistics, as reported at December 31 of each year [12]. The incidence rates were expressed in terms of 100,000 inhabitants.

In our study we apply joinpoint log linear regression to identify the years in which changes in tendency occurred in the rates for admissions for asthma exacerbations among children and young adults, as well as to estimate the annual percentage of change (APC) in each of the periods delimited by the points of change. The analysis started with the minimum number of joinpoints and tested if the inclusion of one or more joinpoints were statistically significant [13]. In the final model, each joinpoint indicated a significant change in the tendency, and the APC was obtained in each of the segments delimited by the joinpoints, by means of the technique of weighted least squares. The Joinpoint Regression Program, version 4.0.4 was used for the analysis [14].

Data were treated with full confidentiality, according to the Spanish legislation. Patient identifiers were deleted before the database was provided to the authors in order to keep strict patient confidentiality. It is not possible to identify patients at individual levels either in this paper or in the database. Given the anonymous and mandatory nature of the data informed consent was neither required nor necessary. The Spanish Ministry of Health evaluated the protocol of our investigation and considered that it met all ethical aspects according to the Spanish legislation so provided us the anonymous database. For all the previous reasons the requirement for ethical approval was not necessary.

**Results**

We identified a total of 12,038 pediatric patients and 2792 young adults hospitalized for asthma exacerbations from 2002 to 2010. Mean age was 5.79 years (SD, 3.54 years) in pediatric patients and 30.15 years (SD, 8.77 years) in young adults.

Tables 1 and 2 reflect the total number of hospitalizations and the incidence of hospital admissions for asthma exacerbations per 100,000 inhabitants in each year. The overall crude incidence has decreased from 20.5 to 18.7 hospitalizations per 100,000 inhabitants in pediatric patients and from 4.12 to 3.68 hospitalizations per 100,000 inhabitants in young adults from 2002 to 2010 in Spain ($p < 0.05$). When we compared incidence by sexes, we found higher incidence in men than in women for all years analyzed in pediatric patients. By contrast, we found higher incidence in women than in men in young adults hospitalized for asthma exacerbations.

Figs. 1 and 2 shows the time evolution of hospitalizations for asthma exacerbations, in pediatric patients (0–15 years) and in young adults (16–45 years) respectively, according to joinpoint analysis, by sex groups and in total. As can be seen, the incidence of hospitalizations is declining in children at an annual percent change (APC) of around 4.2% for both sexes. Among young adults the APC is slightly higher for men (3.67%) than women (2.56%).

Regarding treatment, we observed changes in the use of ventilatory support during acute asthma exacerbations from 2002 to 2010. In this sense, we detected a significant increase in the use of NIV in both groups, pediatric patients (Table 3) and young adults (Table 4). However, the use of IMV was not significantly reduced over time in neither case.

In our study, the mean LOS for hospital admissions for asthma exacerbations in pediatric patients decreased significantly from 3.71 (2.88) days in 2002 to 3.16 (2.11) days in 2010 ($p < 0.05$). In young adults, the mean LOHS for hospital admissions for asthma exacerbations was 5.36 (4.02) days in 2002 and 5.16 (5.39) days in 2010, but no significant changes were detected over the period of study.

The mean cost per patient decreased from 1558.53 (443.63) Euros in 2002 to 1378.41 (472.71) Euros in 2010 in the group of pediatric patients ($p < 0.05$). By contrast, the mean cost per patient increased from 2183.44 (783.15) Euros in 2002–2564.32 (1933.98) Euros in 2010 in young adults ($p < 0.05$).

IHM was very low. Throughout the study period, only 1 patient (0.09%) died in the group of pediatric patients and 3 patients (0.31%) died in the group of young adults. No significant changes were detected over the period of study in neither case.

**Discussion**

Using the Spanish National Hospital Database, we found a significant decrease in the hospitalizations rates for asthma exacerbations from 2002 to 2010 among pediatric patients and young adults. In contrast, use of NIV increased significantly over this same period in both groups. Other marked temporal trends seen over the study period included a decrease of mean LOS and costs among pediatric patients and an increase of costs among young adults. IHM was negligible during the study period. As there are no similar studies in Spain, it is necessary to make comparisons with other countries.

In the last decades of the twentieth century, hospital admission rates for childhood asthma patients increased in many countries, suggesting a worldwide trend [15–17]. In this sense, Rottem et al [6] found a significant increase in admissions for childhood asthma from 1990 to 1999. Later, Akimbami et al. [18] reported, after a significant increase in the 1980s, a non significant annual decrease in the hospitalization rate for childhood asthma between 1991 and 2006 using the National Hospital Discharge Survey. However, as in our own, more recent studies have shown a significant decline in asthma hospitalizations among children [7,19,20]. Although unclear, the decrease in hospitalization rate may be explained by a decrease in the frequency and severity of asthma exacerbations. However, it could be argued that cases of severe asthma are becoming more
### Table 1
Incidence rates per 100,000 inhabitants, mean length of stay (LOS) and costs of pediatric patients (0–15 years) hospitalized for asthma exacerbation in Spain from 2002 to 2010.

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–2 years</td>
<td>397 (33.33)</td>
<td>390 (31.45)</td>
<td>439 (34.08)</td>
<td>447 (33.74)</td>
<td>629 (46.05)</td>
<td>402 (28.87)</td>
<td>407 (28.41)</td>
<td>422 (28.72)</td>
<td>466 (30.97)</td>
</tr>
<tr>
<td>3–5 years</td>
<td>309 (27.77)</td>
<td>381 (33.07)</td>
<td>419 (34.87)</td>
<td>350 (27.96)</td>
<td>439 (33.98)</td>
<td>241 (18.03)</td>
<td>297 (21.54)</td>
<td>301 (21.23)</td>
<td>374 (26.13)</td>
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<tr>
<td>6–8 years</td>
<td>232 (20.25)</td>
<td>233 (20.22)</td>
<td>264 (22.7)</td>
<td>218 (18.5)</td>
<td>317 (26.25)</td>
<td>206 (16.44)</td>
<td>207 (15.8)</td>
<td>205 (15.21)</td>
<td>240 (17.41)</td>
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<tr>
<td>9–12 years</td>
<td>261 (15.91)</td>
<td>253 (15.42)</td>
<td>255 (15.59)</td>
<td>219 (13.48)</td>
<td>232 (14.31)</td>
<td>166 (10.21)</td>
<td>160 (9.7)</td>
<td>162 (9.64)</td>
<td>194 (11.3)</td>
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<td>13–15 years</td>
<td>116 (8.76)</td>
<td>127 (9.68)</td>
<td>116 (8.88)</td>
<td>118 (9.07)</td>
<td>97 (7.49)</td>
<td>114 (8.85)</td>
<td>86 (6.7)</td>
<td>60 (4.69)</td>
<td>70 (5.51)</td>
</tr>
<tr>
<td>Total</td>
<td>1315 (20.5)</td>
<td>1384 (21.3)</td>
<td>1493 (22.64)</td>
<td>1352 (20.21)</td>
<td>1714 (25.26)</td>
<td>1129 (16.4)</td>
<td>1157 (16.57)</td>
<td>1150 (16.24)</td>
<td>1344 (18.7)</td>
</tr>
<tr>
<td><strong>Mean LOS (days)</strong></td>
<td>3.71 (2.88)</td>
<td>3.46 (2.45)</td>
<td>3.23 (2.09)</td>
<td>3.51 (2.6)</td>
<td>3.3 (2.05)</td>
<td>3.42 (2.5)</td>
<td>3.38 (2.52)</td>
<td>3.21 (2.19)</td>
<td>3.16 (2.11)</td>
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<tr>
<td><strong>Mean Costs (€)</strong></td>
<td>1558.53 (443.63)</td>
<td>1647.94 (451.23)</td>
<td>2021.43 (515.98)</td>
<td>2016.98 (553.53)</td>
<td>1388.66 (688.01)</td>
<td>1454.81 (799.91)</td>
<td>1347 (656.59)</td>
<td>1401.98 (636.07)</td>
<td>1378.41 (472.71)</td>
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**Notes:**
- p < 0.05.
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<td>407 (7.05)</td>
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<td>328 (5.8)</td>
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<td>302 (5.48)</td>
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<td>274 (5.11)</td>
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<td>2007</td>
<td>287 (5.49)</td>
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<tr>
<td>2008</td>
<td>221 (4.34)</td>
</tr>
<tr>
<td>2009</td>
<td>246 (4.94)</td>
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<td>2010</td>
<td>225 (4.62)</td>
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<td>2003</td>
<td>387 (5.48)</td>
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<td>2004</td>
<td>303 (4.19)</td>
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<tr>
<td>2005</td>
<td>292 (3.96)</td>
</tr>
<tr>
<td>2006</td>
<td>347 (4.65)</td>
</tr>
<tr>
<td>2007</td>
<td>316 (4.2)</td>
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<td>2009</td>
<td>280 (3.75)</td>
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<td>289 (4.27)</td>
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<th>Year</th>
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<td>2002</td>
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<td>883 (4.49)</td>
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<td>2009</td>
<td>807 (4.08)</td>
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<tr>
<td>Male</td>
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<td>Female</td>
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<tr>
<td>Male</td>
<td>390 (36.62)</td>
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<tr>
<td>Female</td>
<td>675 (63.38)</td>
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<table>
<thead>
<tr>
<th>LOS Mean</th>
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<tr>
<td>2002</td>
<td>5.36 (4.02)</td>
</tr>
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<td>2003</td>
<td>4.82 (3.23)</td>
</tr>
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<td>2004</td>
<td>4.91 (4.59)</td>
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<td>2005</td>
<td>5.01 (4.39)</td>
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<td>2006</td>
<td>4.72 (3.25)</td>
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<td>2007</td>
<td>4.78 (4.03)</td>
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<td>2008</td>
<td>5.11 (4.51)</td>
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<td>2009</td>
<td>4.94 (4.69)</td>
</tr>
<tr>
<td>2010</td>
<td>5.16 (5.39)</td>
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<table>
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<tr>
<th>Costs Mean</th>
<th>(€) (sd)</th>
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<tbody>
<tr>
<td>2002</td>
<td>2183.44 (783.15)</td>
</tr>
<tr>
<td>2003</td>
<td>2269.02 (878.33)</td>
</tr>
<tr>
<td>2004</td>
<td>2436.9 (1098.78)</td>
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<td>2005</td>
<td>2538.84 (1180.02)</td>
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<tr>
<td>2006</td>
<td>2043.09 (1267.4)</td>
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<tr>
<td>2007</td>
<td>2158.38 (1408.25)</td>
</tr>
<tr>
<td>2008</td>
<td>2500.34 (1118.54)</td>
</tr>
<tr>
<td>2009</td>
<td>2620.66 (3092.75)</td>
</tr>
<tr>
<td>2010</td>
<td>2564.32 (1933.98)</td>
</tr>
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<sup>a</sup> p < 0.05.
effectively managed out of hospital [21]. Improvement in asthma management following the introduction of clinical guidelines may have contributed as well [1,2].

Among adults, although some authors have found a significant increase in hospital admissions for asthma [8], others have showed a tendency toward a reduction [22,23], as in our case. The implementation of programs of interventions aimed at organizing healthcare systems, together with programs of asthma education for health professionals and patients can help to reduce the number of hospital admissions [21,24].

Considering that it is assumable that the patients who are more frequently hospitalized are commonly the most severe ones, it can be hypothesized that the use of monoclonal anti-IgE antibodies in these patients could have a relevant impact in this sense, since this treatment have shown a particularly significant effect on asthma exacerbations and hospitalizations [25]. Interestingly, whereas in 2006 a huge peak in asthma hospitalizations is patent among children younger than 13 years of age, the trend continued decreasing in an almost constant fashion in the rest of age ranges. However, this drug was introduced in Spain in 2006 for adolescents and adults, and approved for children aged 6 to 12 in 2009. According to data published, the number of patients receiving it in Spain is still small [26,27]. Consequently, it is logical to suppose that it will be necessary more years of follow up to observe the beneficial effect on hospitalization rates. The explanation for the year 2006 peak will require further investigation including the effect of influenza and other respiratory viral infections in that year among younger children.

In our study, we have shown that declining hospitalization rates for asthma contrast with increasing use of NIV, raising the possibility that advanced respiratory support is being performed at an earlier phase on less critically ill patients with asthma exacerbations. Other studies have also shown an increase in the application of this type of NIV in emergency care for asthmatic patients [28]. These findings are consistent with a previous study of children with status asthmatics that reported lower hospitalization rates and higher intensive care unit admissions between 1992 and 2006 [29]. However, population rates of mechanical ventilation were low and stable over time. Trends in asthma admissions with time in adult critical care units show that the number of admissions is also rising among adults [30]. These data may indicate trends toward better outpatient
Figure 2  Jointpoint analysis in annual hospital admissions for asthma exacerbations in young adults (16—45 years) in Spain, 2002—2010: men (2A), women (2B), total (2C). Footnote: APC: Annual percent change (based on rates that were sex and age-adjusted using the Spanish National Statistics Institute projections) calculated by using jointpoint regression analysis. *APC is significantly different from zero (two-side $p < 0.05$).

Table 3  Use of non-invasive ventilation (NIV) and invasive mechanical ventilation (IMV) for asthma exacerbations in pediatric patients (0—15 years) in Spain from 2002 to 2010.

<table>
<thead>
<tr>
<th>Year</th>
<th>NIV</th>
<th>IMV</th>
<th>NIV</th>
<th>IMV</th>
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<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
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<td>97.93</td>
<td>1157</td>
<td>100.00</td>
</tr>
<tr>
<td>2009</td>
<td>1112</td>
<td>96.70</td>
<td>1144</td>
<td>99.48</td>
</tr>
<tr>
<td>2010</td>
<td>1319</td>
<td>98.14</td>
<td>1340</td>
<td>98.70</td>
</tr>
</tbody>
</table>

\[a \ p < 0.001.\]

Table 4  Use of non-invasive ventilation (NIV) and invasive mechanical ventilation (IMV) for asthma exacerbations in young adults (16—45 years) in Spain from 2002 to 2010.

<table>
<thead>
<tr>
<th>Year</th>
<th>NIV</th>
<th>IMV</th>
<th>NIV</th>
<th>IMV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>2002</td>
<td>778</td>
<td>99.62</td>
<td>772</td>
<td>98.85</td>
</tr>
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<td>2003</td>
<td>1061</td>
<td>99.62</td>
<td>1053</td>
<td>98.87</td>
</tr>
<tr>
<td>2004</td>
<td>885</td>
<td>98.55</td>
<td>885</td>
<td>98.55</td>
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<tr>
<td>2005</td>
<td>875</td>
<td>99.54</td>
<td>869</td>
<td>98.86</td>
</tr>
<tr>
<td>2006</td>
<td>886</td>
<td>99.66</td>
<td>878</td>
<td>99.76</td>
</tr>
<tr>
<td>2007</td>
<td>780</td>
<td>98.86</td>
<td>776</td>
<td>98.35</td>
</tr>
<tr>
<td>2008</td>
<td>709</td>
<td>99.01</td>
<td>715</td>
<td>98.62</td>
</tr>
</tbody>
</table>

\[a \ p < 0.001.\]
and emergency department management of asthma exacerbations, a higher threshold for hospital admissions, and a lower threshold for admissions in critical care units, rather than any true increase in numbers of those with severe disease [23,24].

When examining trends in costs, we observed a significant decrease for children with asthma during the study time. The reductions in hospitalizations and LOS may account for these findings. Other authors have also observed that inpatient expenditures have decreased during the same period, while prescription expenditures have increased [31,32]. However, in our study, the average annual cost per patient increased among young adults hospitalized for asthma exacerbations from 2002 to 2010, despite significant reduction in hospitalization rates in these patients. Although there may be many reasons for increasing hospital charges, more intensive use of resources, as we have seen with non-invasive respiratory support, could help to justify these findings [7]. The lack of significant reduction in LOS in this group of patients during the study period may have contributes as well.

IHx was rare in our study, as in others [6,24]. Although we can not to completely rule out the deaths of patients who were not admitted, this possibility is highly unlikely. Reduced mortality may reflect availability and utilization of healthcare, access to an appropriate use of treatment modalities and prevention strategies, low severity of disease, and low prevalence of co-morbidities [6,7].

We should recognize strength and limitations of the current study. The main strength lies in its large sample size and its standardized methodology maintained constant during the study period. Furthermore, discharge databases have been used by other authors to assess outcomes, burden and trends of hospital admissions for asthma exacerbations [7,20,28]. Nevertheless, our study is subject to a series of limitations. First, a potential source of bias comes from use of ICD-9-CM diagnosis codes to identify patients hospitalized for asthma exacerbations. To use only the codes 493.0x–493.9x can somehow bias the selection of patients, particularly among children aged 0–5. Indeed, there exists a patent reluctance to use the term “asthma” in children in this group of age, and the use of other euphemistic alternative terms like “wheeze” or “bronchospasm” are commonly used. Considering that the ICD-9-CM encloses codes not included in the 493.xx group for bronchospasm (i.e. 519.11, 466.19, 466.11) and for wheeze (i.e. 786.07) it is conceivable that a significant proportion of children between 0 and 5 years of age with the same clinical picture have been missed as a consequence of the use of these alternative codes, and this fact can bias the diagnosis more in infants and pre-school children than in the rest of age ranges. However, the Spanish Ministry of Health included the code 519.11 in year 2008 so we think the effect on our results would be of a small magnitude. With regard to codes for bronchiolitis 466.19 and 466.11 (primary diagnoses), the behavior for the age group 0–4 years has been similar to that observed for asthma across the study period. Finally, the code for wheeze (i.e. 786.07) as primary diagnoses is very rarely used in Spain. So as with the case of bronchospasm if there is a misclassification bias for bronchiolitis we believe it has possibly been non-differential so it would not affect much the validity of our results.

In relation to older patients, we might have underestimated or overestimated the frequency of asthma admissions and misdiagnosed lower respiratory tract infections, such as bronchitis and pneumonia. However, this is a limitation in virtually all studies of asthma epidemiology [30] and the frequency of cross over in this study is unlikely to be different in any other. In any case, other studies of trends in asthma hospitalizations have used the same codes, and those who have conducted sensitivity analyses to address this issue have concluded that it is difficult to postulate that diagnostic substitution explains the observed trend [7]. Second, our data source was the CMBD, an administrative database that contains discharge data for Spanish hospitalizations and uses the information that the physician has included in the discharge report; therefore, it does not include all the variables of the clinical history such as the history of asthma and prehospitalization levels of severity and control, severity of the exacerbations, pharmacologic treatments, or response to NIV treatment, among others. Another limitation of this database is its anonymity (no identifying items such as clinical history number), which makes it impossible to detect whether the same patient was admitted more than once during the same year. In addition, patients who moved from one hospital to another would appear twice.

Despite these limitations, this dataset, which was introduced in Spain in 1982, is a mandatory register, its coverage is estimated to be greater than 95%, and it is periodically audited [33]. In addition, Spain is a large country with a public health system providing full free of charge medical services to the entire population, so patients come from a variety of socioeconomic categories improving the external validity of the current results.

In conclusion, this study provides data indicating that the incidence of hospital admissions for asthma exacerbations decreased in Spain from 2002 to 2010 among children and young adults, with increased use of NIV and reduced mortality rates in both groups. Outcomes such as mean LOS and costs decreased among children while unchanged and increased, respectively, among young adults. These findings indicate that, probably, the management of the patients undergoing asthma exacerbations has improved in Spain during the study period. In any case, this temporal trend points to a decrease in the burden of asthma for hospitalizations in Spain, and may be useful for planning future resources.

Conflicts of interest
The authors report no conflicts of interest.

References


