Close correlation between anxiety, depression, and asthma control

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KEYWORDS
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Depression

Summary

Background: We investigated the correlation between patients’ characteristics, including anxiety and depression, and the level of asthma control evaluated by asthma control test (ACT), a self-administered validated questionnaire.

Methods: This is a cross-sectional study on asthmatic outpatients of three Italian hospitals. Demographic data, spirometry, anxiety and depression scores as well as the level of asthma control from 315 patients were collected.

Results: Patients with poorly controlled asthma were more frequently women, older, with a worse pulmonary function, obese, more anxious and/or more depressed. Four different independent factors associated with poor asthma control evaluated by ACT have been found: FEV1 < 60% (odds ratio, OR: 6.52), anxiety (OR: 3.76), age ≥ 65 years (OR: 2.69), and depression (OR: 2.45). The presence of anxiety and depression was associated with a higher healthcare utilization. Finally, we found a high level of agreement between ACT and multidimensional GINA approach in evaluating asthma control, with a concordance in 239 patients (81% of the population).

Conclusion: There is a close correlation between anxiety and depression, and a poor asthma. A better understanding of this association may have major clinical implications, mainly in patients with poor controlled asthma in whom the presence of anxiety and depression should be investigated.

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Abbreviations: ACT, Asthma Control Test; BMI, body mass index; CI, confidence interval; ED, emergency department; FEV1, forced expiratory volume in 1 s; GINA, Global Initiative for Asthma; HAD, Hospital Anxiety and Depression scale; OR, odds ratio; SD, standard deviation.

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Introduction

The latest version of the international guidelines on asthma management (GINA)\(^1\) points to the concept that asthma control is currently considered the target of treatment and a key point not only to judge the severity of the disease but also to manage the pharmacological treatment by a step-up and step-down approach. Some tools have been developed to quantify asthma control,\(^2\)\(^3\) such as the Asthma Control Test (ACT), a validated self-administered questionnaire that does not include a measure of lung function, designed to capture the multidimensional nature of asthma control and to demonstrate good predictive properties for assessing asthma clinical control.\(^5\)

Several studies well demonstrated the high prevalence of psychiatric disorders, mainly anxiety and depression but also posttraumatic stress disorder, in patients suffering from asthma\(^6\)\(^8\); interestingly, the association between asthma and psychiatric disorders was also confirmed in a large survey carried out in 17 countries in Americas, Europe, Middle East, Asia and South Pacific, that included patients markedly differing in culture, language and level of socioeconomic development.\(^9\) Another large study demonstrated that children and adolescent with asthma have a 2-fold higher risk of developing at least a depressive or anxiety disorder.\(^10\) Some authors hypothesized that stress associated with chronic illness increases the likelihood of developing anxiety and depressive symptoms: notably, it has been demonstrated that anxiety and depression are more frequent in asthmatic patients than in patients with other chronic diseases, such as chronic hepatitis, a pathology that affects patients’ daily approach to living with the disease.\(^11\) Moreover, in patients with difficult asthma a high prevalence of undiagnosed psychiatric morbidity, particularly depression, has been reported\(^12\) and, in turn, psychological factors such as anxiety, depressive disorders and/or personality disorders may predispose asthmatic patients to near fatal or fatal asthma.\(^13\)

On the basis of these observations, we investigated the influence of patients’ characteristics, including anxiety and depression, on the level of asthma control assessed by a self-administered questionnaire such as ACT.

Methods

Study design and population

This was a cross-sectional study on asthmatic outpatients of tertiary asthma clinics of three Italian hospitals (San Paolo, University Hospital, Milan; Policlinico, University Hospital, Messina, and Fondazione Maugeri, Tradate). Consecutive patients aged \(>18\) years, diagnosed with asthma of all severity levels and attending the Respiratory Unit of the participating hospitals for scheduled visits between January and April 2007 were enrolled. All patients had symptoms consistent with the diagnosis of asthma and a \(>12\)% increase in forced expiratory volume in 1 s (FEV\(_1\)) following 400 \(\mu\)g of inhaled salbutamol or a provocative concentration of methacholine causing a 20% fall in FEV\(_1\) (PC20) \(<8\) mg mL\(^{-1}\). All patients were receiving pharmacological treatment according to GINA guidelines. The local research ethics committees approved the study and all patients gave written informed consent.

Data collected

The following data were collected: (1) demographic data (age, sex, body mass index – BMI), smoking history, education level, and atopy; (2) spirometry, performed according to the ATS/ERS guidelines,\(^14\) using predicted values for FEV\(_1\) and forced vital capacity based on the European Coal and Steel Union reference value\(^15\); (3) anxiety and depression level, assessed with the Hospital Anxiety and Depression scale (HAD), which is self-reported and has been extensively used to screen psychiatric morbidity\(^16\) in a diverse range of clinical groups, including asthmatic patients.\(^17\)\(^18\) It is comprised of two parts, the first with seven questions related to anxiety and the second with seven questions related to depression. The maximum score for anxiety and depression is 21; a score \(\geq 8\) on either part was used as a cut-off point for diagnosing anxiety and depression\(^19\); (4) level of asthma control, assessed by both Asthma Control Test (ACT)\(^3\) and GINA approach\(^1\); the latter includes patient history, physical examination and spirometry (FEV\(_1\); percent of predicted values and relation to the patients’ personal best). According to GINA guidelines the disease was defined poorly controlled when three or more features of partly controlled asthma (diurnal or nocturnal asthma symptoms, limitations of activities, need for reliever/rescue treatment, exacerbations, FEV\(_1\) \(<80\)% of predicted or personal best) were present in any of the past 4 weeks. This evaluation was carried out by treating doctor, strictly on the basis of GINA guidelines (Table 4.3-1, page 58, version updated 2007), that was blind about the results of ACT and HAD questionnaires. The ACT questionnaire is a validated self-administered questionnaire including five questions related to the last 4 weeks: episodes of breathlessness, nocturnal awakenings, limitations of daily activities, need for rescue medication, and patient self-rating of asthma control.

Each question includes five response modalities with a score ranging from 1 to 5 by increasing the level of asthma control, so the global arithmetic score ranges from 5 to 25. Well controlled asthma by ACT was defined by a score \(\geq 20\).\(^3\)

Analysis

The results are shown as mean \(\pm\) standard deviation (SD) unless otherwise stated. The sample size was tailored on the multivariate analysis (see below). On the expected basis of almost 20% of patients with poorly controlled asthma, a sample size of 300 patients was estimated in order to include in the multifactorial analysis at least six factors (one factor every 10 cases). Continuous variables were compared using \(t\)-test and analysis of variance (ANOVA) and, if positive, post hoc comparisons were carried out by \(t\)-test with Bonferroni adjustment, and dichotomous variables using chi-square or a Fischer exact test. For categorisation of continuous variable international accepted cut-off values was used (e.g. for FEV\(_1\), BMI), whilst for age the fourth quintile cut-off value was used. A logistic regression analyses was performed to identify variables significantly associated with asthma control evaluated by ACT questionnaire. Variables yielding \(p\)-values lower than
0.20 in the univariate analyses were entered into regression model where not controlled asthma (ACT score <20) was the outcome variable of interest. Finally, by using Pearson product moment correlation coefficients, the association between anxiety, depression and the answer to the fifth question of ACT (How would you rate your asthma control during the past 4 weeks?), which reflects the patients’ “perceived” level of asthma control, was analysed. All tests were two-sided, and p-values lower than 0.05 were considered statistically significant. Statistical tests were performed using the Statistical Package for Social Sciences (SPSS, Chicago, USA).

**Results**

A total of 315 patients were enrolled in the study, but 21 cases were excluded from the analysis for missing data. Thus, data were available for 294 patients.

**Features of enrolled patients according to sex and asthma control**

Table 1 shows the characteristics of the overall population, such as variables distribution according to sex and asthma control. As expected, the sample included a majority of women characterized, in comparison with males, by higher mean age, longer asthma duration, lower level of asthma control, higher rate of emergency department visits for asthma, higher level of anxiety and depression, although the differences in terms of FEV1, BMI, atopy and smoking history were not statistically significant. Seventy-one percent of the enrolled patients referred a well controlled asthma by ACT (score ≥20), whilst treating doctors judged the disease well controlled using the multidimensional GINA approach in 87% of the sample. As shown in Table 1, patients with a poorly controlled asthma (ACT score <20) were more frequently women, older, with a worse pulmonary function and a higher rate of urgent care visits for asthma, more frequently obese, more anxious and/or more depressed in comparison with patients with a well controlled disease (ACT score ≥20). The level of education did not result to be significantly associated either with sex, or with the level of asthma control.

**Fig. 1** shows the scores of anxiety and depression according to the patients’ “perceived” overall level of asthma control evaluated by the fifth question of ACT (How would you rate your asthma control during the past 4 weeks?). A constant trend of reduction in anxiety and depression was found with increasing level of asthma control.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>All (%)</th>
<th>Females</th>
<th>Males</th>
<th>P</th>
<th>Well control by ACT</th>
<th>Poor control by ACT</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants, n (%)</td>
<td>294</td>
<td>198 (67)</td>
<td>96 (33)</td>
<td></td>
<td>208 (71)</td>
<td>86 (29)</td>
<td></td>
</tr>
<tr>
<td>Age, year</td>
<td>51 ± 17</td>
<td>53 ± 16</td>
<td>47 ± 18</td>
<td>.002</td>
<td>49 ± 16</td>
<td>56 ± 17</td>
<td>.001</td>
</tr>
<tr>
<td>FEV1, (% of predicted values)</td>
<td>88 ± 13</td>
<td>88 ± 14</td>
<td>88 ± 12</td>
<td>.659</td>
<td>89 ± 11</td>
<td>85 ± 16</td>
<td>.017</td>
</tr>
<tr>
<td>≥80, n (%)</td>
<td>238 (81)</td>
<td>161 (81)</td>
<td>77 (80)</td>
<td>.849</td>
<td>173 (84)</td>
<td>65 (75)</td>
<td>.005</td>
</tr>
<tr>
<td>60–80, n (%)</td>
<td>45 (15)</td>
<td>29 (15)</td>
<td>16 (17)</td>
<td></td>
<td>32 (15)</td>
<td>13 (15)</td>
<td></td>
</tr>
<tr>
<td>&lt;60, n (%)</td>
<td>11 (4)</td>
<td>8 (4)</td>
<td>3 (3)</td>
<td></td>
<td>3 (1)</td>
<td>8 (9)</td>
<td></td>
</tr>
<tr>
<td>Atopy, n (%)</td>
<td>190 (65)</td>
<td>124 (63)</td>
<td>66 (69)</td>
<td>.363</td>
<td>133 (64)</td>
<td>57 (66)</td>
<td>.789</td>
</tr>
<tr>
<td>Asthma duration, year</td>
<td>12 ± 2</td>
<td>14 ± 14</td>
<td>9 ± 8</td>
<td>.005</td>
<td>13 ± 13</td>
<td>12 ± 11</td>
<td>.565</td>
</tr>
<tr>
<td>Smoking: non-smoker</td>
<td>174 (59)</td>
<td>121 (61)</td>
<td>53 (56)</td>
<td>.191</td>
<td>123 (59)</td>
<td>51 (59)</td>
<td>.977</td>
</tr>
<tr>
<td>Past-smoker</td>
<td>91 (31)</td>
<td>55 (28)</td>
<td>36 (37)</td>
<td></td>
<td>64 (31)</td>
<td>27 (32)</td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>29 (10)</td>
<td>22 (11)</td>
<td>7 (7)</td>
<td></td>
<td>21 (10)</td>
<td>8 (9)</td>
<td></td>
</tr>
<tr>
<td>BMI (Kg/m²)</td>
<td>25.9 ± 5.9</td>
<td>25.8 ± 6.3</td>
<td>26.0 ± 4.9</td>
<td>.786</td>
<td>25.4 ± 5.8</td>
<td>27.1 ± 5.9</td>
<td>.030</td>
</tr>
<tr>
<td>&lt;25, n (%)</td>
<td>149 (50)</td>
<td>101 (51)</td>
<td>48 (50)</td>
<td>.889</td>
<td>115 (55)</td>
<td>34 (40)</td>
<td>.031</td>
</tr>
<tr>
<td>25–30, n (%)</td>
<td>96 (33)</td>
<td>63 (32)</td>
<td>33 (35)</td>
<td></td>
<td>64 (31)</td>
<td>32 (37)</td>
<td></td>
</tr>
<tr>
<td>&gt;30, n (%)</td>
<td>49 (17)</td>
<td>34 (17)</td>
<td>15 (15)</td>
<td></td>
<td>29 (14)</td>
<td>20 (23)</td>
<td></td>
</tr>
<tr>
<td>ACT total score</td>
<td>20.4 ± 4.5</td>
<td>19.7 ± 4.7</td>
<td>22.0 ± 3.7</td>
<td>&lt;.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well controlled by ACT, n (%)</td>
<td>208 (71)</td>
<td>132 (67)</td>
<td>76 (79)</td>
<td>.029</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well controlled by GINA, n (%)</td>
<td>257 (87)</td>
<td>169 (86)</td>
<td>88 (92)</td>
<td>.138</td>
<td>205 (99)</td>
<td>52 (60)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Anxious patients, n (%)</td>
<td>114 (39)</td>
<td>96 (49)</td>
<td>18 (19)</td>
<td>&lt;.001</td>
<td>60 (29)</td>
<td>54 (63)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Depressed patients, n (%)</td>
<td>80 (27)</td>
<td>64 (32)</td>
<td>16 (17)</td>
<td>.005</td>
<td>38 (18)</td>
<td>42 (49)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Patients anxious and depressed, n (%)</td>
<td>54 (18)</td>
<td>48 (24)</td>
<td>6 (6)</td>
<td>&lt;.001</td>
<td>22 (11)</td>
<td>32 (37)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>≥1 ED visit* in previous year, n (%)</td>
<td>24 (8)</td>
<td>21 (11)</td>
<td>3 (3)</td>
<td>.039</td>
<td>15 (7)</td>
<td>9 (11)</td>
<td>.356</td>
</tr>
<tr>
<td>≥ urgent care visit* in previous year, n (%)</td>
<td>55 (19)</td>
<td>39 (20)</td>
<td>16 (17)</td>
<td>.633</td>
<td>29 (14)</td>
<td>26 (30)</td>
<td>.002</td>
</tr>
</tbody>
</table>

Well controlled asthma by ACT: score ≥20; ED, emergency department; *visit for asthma; in bold P < 0.05.
control, i.e. going from the two lowest level of control (not controlled at all and poorly controlled asthma) towards a well controlled asthma \( (P < .001 \text{ for ANOVA analysis, for both anxiety and depression}) \). The level of \( \text{FEV}_1 \), then, did not result significantly associated with the level of anxiety \( (P = .244) \) or depression \( (P = .064) \).

**Multivariate analysis for poor asthma control evaluated by ACT**

The multivariate analysis shown in Table 2 includes risk factors of poorly controlled asthma detected in the univariate analysis, such as female sex, age \( \geq 65 \) years, anxiety, depression, \( \text{FEV}_1 \), and BMI. From the multivariate analysis four different independent factors associated with poor asthma control evaluated by ACT were found: \( \text{FEV}_1 < 60\% \) of the predicted value, anxiety, age \( \geq 65 \) years, and depression (see Table 2); the odds ratio (OR) for poorly controlled asthma were 6.52, 3.76, 2.69, and 2.45, respectively.

**Features of enrolled patients according to psychological profile**

Table 3 shows the features of patients according to the psychological profile. More than confirming the association between the psychological profile and asthma control, depressed patients were found to be older and more frequently obese (BMI \( >30 \text{ Kg/m}^2 \)); moreover, we found a significant correlation between the psychological profile and healthcare utilization, with a higher rate of urgent care visit in patients with concomitant anxiety and depression, and a higher rate of emergency department visit for asthma in anxious patients (Table 3).

**Comparison of ACT and multidimensional GINA approach in asthma control evaluation**

A high agreement of ACT questionnaire in evaluating asthma control when compared with the multidimensional GINA approach was found, with a concordance in 239 patients over 294 (81% of the population); in case of discordance, a lower level of asthma control by ACT was predominant (54 patients, 18% of the studied population), whilst the opposite (lower level of asthma control by GINA approach compared to ACT) was very rare (three patients corresponding to 1% of studied patients). In this context, no significant difference between males and females was found.

**Table 2** Multivariate logistic regression model: risk factors of poorly controlled asthma (ACT score \( <20 \)).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female sex</td>
<td>1.04</td>
<td>0.53–2.04</td>
<td>.901</td>
</tr>
<tr>
<td>Age ( \geq 65 ) years</td>
<td>2.69</td>
<td>1.40–5.15</td>
<td>.003</td>
</tr>
<tr>
<td>( \text{FEV}_1 ), (% of predicted values)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \geq 80 )</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60–80</td>
<td>.75</td>
<td>0.33–1.70</td>
<td>.487</td>
</tr>
<tr>
<td>(&lt; 60 )</td>
<td>6.52</td>
<td>1.52–27.92</td>
<td>.012</td>
</tr>
<tr>
<td>BMI (Kg/m(^2))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \leq 25 )</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25–30</td>
<td>1.60</td>
<td>0.84–3.07</td>
<td>.154</td>
</tr>
<tr>
<td>( &gt;30 )</td>
<td>1.54</td>
<td>0.74–3.18</td>
<td>.247</td>
</tr>
<tr>
<td>Anxiety</td>
<td>3.76</td>
<td>1.98–7.14</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Depression</td>
<td>2.45</td>
<td>1.30–4.62</td>
<td>.006</td>
</tr>
</tbody>
</table>

In bold \( P < 0.05 \).

**Figure 1** Anxiety and depression (by HAD questionnaire) mean score (bars represent the standard errors of the mean) according to the perceived level of asthma control evaluated by the 5th question of ACT (How would you rate your asthma control during the past 4 weeks?). \( P < .001 \text{ for ANOVA analysis, for both anxiety and depression} \).
As shown in Fig. 2, patients with a well controlled asthma according to GINA approach but not by ACT showed a psychological profile similar to that of patients with a poorly controlled asthma as judged by both ACT and GINA approach, i.e. their anxiety and depression score was significantly higher in comparison with well controlled patients by both GINA approach and ACT. Notably, the percentage of anxiety and depression was double in these patients by both GINA approach and ACT. Notably, the prevalence of anxiety and depression of 34.9 and 32.3%, respectively.22 The correlation between psychiatric disorders and asthma control we have found becomes more evident in the light of the conclusions by Laforest et al.,20 who investigated the relationships between asthma control and patients characteristics or asthma management. The authors observed that female sex, active smoking and overweight status are independent patient-related determinants of low disease control. Interestingly, the highest odds ratio was 3.55 for active smoking (≥10 cigarettes daily), close to the odds ratio we found for anxiety, 3.76. In this regard, active smoking is worldwide considered a major determinant for poor asthma control, due to worsening of the underlying bronchial inflammation. However, in our study only a limited number of asthmatic patients was exposed to significant active smoking (≥10 cigarettes daily), whilst anxiety and depression are indeed frequent in asthmatic patients. Notably, we found a prevalence of anxiety and depression of 39 and 27%, respectively. Cooper et al.,21 using the same questionnaire (HAD) found a score higher than 8 for anxiety, 25–30, and depression (OR: 2.45), which are frequent disorders in asthmatic subjects. Moreover, the presence of anxiety and depression was associated with a higher healthcare utilization.

Lavoie et al.19 found that depressive and anxiety disorders are independently associated with low asthma-related quality of life, but that only depressive disorders are independently associated with low levels of asthma control. In particular, a trend toward a greater bronchodilator use was observed in patients with anxiety disorders (despite having better overall levels of asthma control) than in patients with depressive disorders.

Discussion

The aim of this study was to investigate the correlation between patients’ characteristics, including anxiety and depression, and the level of asthma control evaluated by GINA/ACT discordance in comparison with well controlled patients by both GINA approach and ACT. Notably, the percentage of anxiety and depression was double in these patients with GINA/ACT discordance in comparison with patients with a normal perception of a well controlled asthma by GINA approach but not by ACT. The results of this study show a significant correlation between a poor level of asthma control and both anxiety (OR: 3.76) and depression (OR: 2.45), which are frequent disorders in asthmatic subjects. Moreover, the presence of anxiety and depression was associated with a higher health care utilization.

The close relation between anxiety, depression and asthma control we have found becomes more evident in the light of the conclusions by Laforest et al.,20 who investigated the relationships between asthma control and patients characteristics or asthma management. The authors observed that female sex, active smoking and overweight status are independent patient-related determinants of low disease control. Interestingly, the highest odds ratio was 3.55 for active smoking (≥10 cigarettes daily), close to the odds ratio we found for anxiety, 3.76. In this regard, active smoking is worldwide considered a major determinant for poor asthma control, due to worsening of the underlying bronchial inflammation. However, in our study only a limited number of asthmatic patients was exposed to significant active smoking (≥10 cigarettes daily), whilst anxiety and depression are indeed frequent in asthmatic patients. Notably, we found a prevalence of anxiety and depression of 39 and 27%, respectively. Cooper et al.,21 using the same questionnaire (HAD) found a score higher than 8 for anxiety and depression respectively in 47 and 22% of the asthmatic population, and Baiardini et al. reported a prevalence of anxiety and depression of 34.9 and 32.3%, respectively.22

The correlation between psychiatric disorders and asthma can be explained on the basis of the following hypotheses23:

1. psychiatric disorders such as anxiety and depression may increase the perception of symptoms thereby reducing the perception of asthma control level;
2. poorly controlled asthma may lead to an increase in anxiety and/or depression.

Even if our study was not specifically designed to answer to this question, the higher prevalence of anxiety and depression in patients with a not well controlled asthma by...
ACT but controlled according to multidimensional GINA approach (Fig. 2) in one hand, and the lack of correlation between pulmonary function test and anxiety and depression (Table 3) in the other hand, may favour the first hypothesis. Thus, on this basis, anxiety or depression may result in poor level of asthma control.

Other factors may also play a role in the relationship between psychiatric disorders and asthma control. For example, it has been shown that asthmatic patients with concomitant depression are less likely to adhere to medication regiments and more likely to require emergency services in comparison with asthmatics patients without depression. Moreover, some studies suggest an autonomic or immunologic mechanism linking depression and poor asthma control, i.e. an increased production of proinflammatory cytokines, even if definitive data are still missing.

Anxiety, on the other hand, may lead to a condition of hypervigilance to bodily sensation and may emphasize minimal respiratory fluctuation considered normal by patients without anxiety disorders. As expected, the level of asthma control resulted to be significantly correlated with healthcare utilization; moreover, we found a significant association between the psychological profile (anxiety and depression) and urgent care or emergency department visits for asthma. This result agrees with previous studies; interestingly, it has been recently demonstrated that youth with asthma and depressive disorders have significantly higher health care utilization and costs, and that most of them are due to increase in non-mental health and non-asthma expenses.

In our study, a higher level of asthma control was found in comparison with other investigations carried out also in primary care, even if it should be underlined that the three centers participating to the study were tertiary asthma clinics, with an anti-smoking center: this is why our population included only 8% of current smokers, with only 3% of enrolled patients smoking more than 10 cigarettes/day. Consequently, we did not find smoking history as one of the independent factors associated with poorly controlled asthma, probably for the low rate of active smoking patients in our sample.

Our results also confirm the significant difference between males and females both in terms of asthma control and psychological profile. This is in line with the data by Laforest et al., indicating female sex as an independent factor associated with poorly controlled asthma, with an odds ratio of 1.63, such as also in the study of McCoy et al. Then, a consistent body of literature found a higher prevalence of anxiety and depression in females compared to males.

Finally, we confirmed the high reliability of ACT as a screening questionnaire for the evaluation of asthma control, strongly concordant with the GINA approach; discordant cases were mainly due to an overestimation of asthma severity by ACT, whereas underestimation of asthma severity by ACT—which may expose the patient to the risk of undertreatment—was extremely rare (1% of patients).

Figure 2  Anxiety and depression (by HAD questionnaire) mean score (bars represent the standard errors of the mean) according to asthma control evaluated by GINA approach and ACT questionnaire. ns, not significant.
asthma control itself. Finally, the present study is not prospective but cross-sectional. However, our results on the prevalence of psychological disorder in asthmatic patients and the relation between these disorders and asthma control are in line, as previously discussed, with results from large and sometimes prospective studies.

In conclusion, we found that anxiety and depression are frequent in asthmatic patients, are associated with a higher healthcare utilization, and that there is a significant correlation between these disorders and a poor asthma control evaluated by ACT. A better understanding of this association may have major clinical implications, mainly in patients with poor asthma control in whom the presence of anxiety and depression should be investigated.

**Conflict of interest statement**

None declared.

**Sources of funding**

None.

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