Self-perceived sleep quality and quantity in adult subjects with asthma: Findings from the CosteAsma study

Short title: Asthma and sleep quality

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Abstract

Background/objective: Nocturnal symptoms of asthma are associated with poor sleep quality, excessive daytime sleepiness and poor daytime functioning. The aim of this study was to describe the asthmatic patient-self perceived sleep quality and quantity in a real-world setting according to different determinants of patient health status. **Methods:** A cross-sectional, observational, seasonal-waves survey was designed. Allergists nationwide were asked to consecutively survey adult asthmatics aged 18-65 years, evenly distributed by seasons and severity (GINA criteria). Sleep quality and quantity were assessed using the self-administered MOS-sleep scale. The Asthma Control Test was applied to ascertain the degree of asthmatic symptoms control.

Results: A total of 1,098 subjects [58.7% females, 41.2 (13.6) years] were included in the analysis. Asthma severity was related with poor sleep quality/quantity, with higher scores in more severe patients ($p<0.001$), who significantly had less daily average hours of sleep: 0.3-0.5 hours ($p<0.001$). Degree of symptoms control and level of patient´s severity were both associated with poor index sleep problems: 25.3 (full control), 26.4 (controlled), 32.6 (partially controlled) and 44.6 (uncontrolled); $p<0.001$, and 48.4 (severe), 39.0 (moderate), 32.6 (mild) and 26.5 (intermittent), $p<0.001$.]. In our study, gender was significantly associated with summary index sleep score. **Conclusion:** Sleep quality and quantity was significantly associated with poor health status of asthmatic patients. Guidelines should recommend both asking nocturnal asthma symptoms and advising clinicians about taking a global sleep history. A better control of nocturnal asthma symptoms could lead to improved sleep quality and a decrease in daytime sleep-related symptoms.

Key words: asthma, real world setting. Sleep quality and quantity, MOS-sleep scale, disability

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Resumen

Introducción/Objetivo: Los síntomas nocturnos de asma, están asociados con la calidad de la falta de sueño, somnolencia diurna excesiva y mal funcionamiento durante el día. El objetivo de este estudio fue describir la calidad y cantidad del sueño percibida por el paciente asmático en un emplazamiento de vida real según diferentes determinantes del estado de salud del paciente. **Métodos**: Se diseñó una encuesta de corte transversal, observacional, en olas estacionales.. Se les pidió a alergólogos de todo el país que realizaran una encuesta de forma consecutiva a asmáticos de 18-65 años, distribuido por estaciones y gravedad (criterios GINA). Cantidad y calidad del sueño se evaluaron utilizando la la escala autoadministrada de sueño MOS-sleep scale. La escala ACT se aplicó para determinar el grado de control de síntomas asmáticos. **Resultados**: Un total de 1.098 sujetos [58.7% mujeres, 41.2 (13,6) años] se incluyeron en el análisis. La gravedad del asma se relacionó con calidad/cantidad de falta de sueño, con puntuaciones más altas en los pacientes más graves (p<0,001), que tenían significativamente menos horas promedio diarias de sueño: 0.3-0.5 horas (p< 0.001). El grado de control de síntomas y nivel de severidad se asociaron con problemas de sueño: 25.3 (control total), 26,4 (controlada), 32.6 (parcialmente controlada) y 44,6 (no controlada); p<0.001 y 48.4 (grave), 39,0 (moderado), 32.6 (leve) y 26,5 (intermitente), p<0.001. En nuestro estudio, el género se asoció significativamente con la puntuación resumen del índice de sueño. **Conclusión**: La cantidad y calidad del sueño se asoció significativamente con el estado de salud de los pacientes asmáticos. Las guías deberían recomendar preguntar tanto por los síntomas de asma nocturno como asesorar a los clínicos acerca de hacer una historia global de sueño Un mejor control de la sintomatología nocturna del asma podría conllevar a una mejor calidad del sueño y una disminución en los síntomas relacionados con el sueño durante el día.

Palabras clave: Asma, emplazamiento vida real, calidad y cantidad de sueño, Escala de sueño MOS, discapacidad

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Introduction

Current guidelines for management of asthma recommend asking about nocturnal asthma symptoms [1]. However, taking a full global sleep history from asthma patients is not advised [1-3]. Therefore, many clinicians are reluctant to ask for sleep problems and/or nocturnal sleep-related disturbances.

Although disturbed sleep is an outcome in patients with asthma, there are relatively few data on the relationship between global sleep quality and quantity, asthma control and functioning during daytime, particularly on a clinical routine basis. Thus, the main goal of this work was to describe the patient-self perceived sleep quality and quantity in subjects with asthma in a real-world setting according to different determinants of patient health status, particularly day-time functioning. This was the secondary objective of a study, the CosteAsma study, which main objective was to determine the impact of asthma on indirect cost and productivity losses in Spain [4].

Patients and Methods

Study design and patient sampling

Characteristics and design of the CosteAsma study has been published elsewhere [4]. In brief, Spanish allergists were invited to participate in a nationwide cross-sectional, multi-wave, observational, epidemiological multicentre study. A stratified multistage probabilistic sample without replacements was selected. The sampling frame was the health regions of the 17 Autonomous Communities of Spain. The study was approved by an institutional review board and the Spanish Ministry of Health.

Selection of patients

Patients enrolled in the study must meet the following inclusion criteria: 1) age 18-65 years; 2) have a confirmed diagnosis of asthma based on the criteria set in the GINA [2] or Guía Española de Manejo del Asma (GEMA, Spanish Guide to Management of Asthma) 2009 guidelines [3] and pulmonary functions tests; 3) signed written informed consent. Patients without a previous

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diagnosis of asthma in their clinical chart, with Chronic Obstructive Pulmonary Disease (COPD) or any other condition precluding their participation or understanding of the study instructions, as well as those not giving their informed consent were excluded from participation. All the data collected were provided by the participants at the study visit, with no additional information sought from other sources. All the participants continued to receive their usual asthma treatment as indicated by their physician.

As this was the secondary objective of the CosteAsma study, no sample size calculation was carried out in advance of the study for this particular objective. However, the sample size of the study (above 1,000 subjects) was considered sufficient to test the objective of this work.

Data collection and measurements

Subjects underwent evaluations that included both data collected by participant physicians and self-completed questionnaires. The data collected were: socio-demographical, clinical and spirometry exploration. The self-completed questionnaires included: Asthma Control Test (ACT)[5], the Sheehan's disability index [6; and the Medical Outcomes Study (MOS)- sleep scale [7,8], all of them in their Spanish versions. It is recommended to complete the test at different times of the year. Some authors classified the degree of asthma control into four categories using the scoring in the ACT: no controlled (<15 points), partially controlled (15-19), controlled (19-24) and full controlled (25 points)[9].

Patient functioning during daytime in the asthmatic subjects included in this study was approached by means of a simple questionnaire exploring the patient level of disability: the Sheehan Disability Index (SDI).. The score ranges from 0 (no disability) to 100 (total disability). Also, the degree of disability may be grouped into four categories [10]: intermittent (≤10 points), mild (11-≤40), moderate (41-≤60) and severe (>60). The patient rates the extent to which his or her 1) work, 2) social life or leisure activities, and 3) home life or family responsibilities are impaired by his or her symptoms on a 10-point visual analogue scale. .

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The MOS-sleep scale is a 12-items self-administered scale. The purpose of the MOS-sleep Scale is to assess the quality and quantity of sleep. Quantity of sleep is scored as the average hours slept per night. The other scales and composite measurement are scored on a transformed 0-100 metric where higher scores indicate more of the concept being assessed.

Statistical Analysis

Descriptive statistics were determined and normal distribution of data was tested using the Kolmogorov-Smirnov test or the Levene test. The *t* test or the 1-factor analysis of variance were used to assess statistical differences in quantitative measures meeting the assumptions necessary for the use of parametric tests; the Mann-Whitney test or the Kruskal-Wallis test was used for differences not meeting these assumptions. The Pearson χ^2 and Fisher exact test were used for 2×2 tables and the likelihood ratio test with m×n tables. A backward stepwise regression multivariate linear model was fitted to explore the association of different variables (determinants) with summary index problem score of the MOS-sleep scale. Determinant included, amongst others, daytime patient functioning as assessed by means of the SDI questionnaire and the level of control of asthma by means of the ACT scale. General linear models with covariates were also used to analyse scores in the MOS-sleep scale (summary index and domains) with patients grouped into categories according with their responses either in the ACT test or the level of severity according to GINA/GEMA classification. Multiple comparisons were adjusted by degrees of freedom according with Bonferroni procedure when applicable. Tests were carried out to determine compliance with the assumptions necessary for the use of parametric contrasts. The estimates were carried out with a 95% confidence level (CI) using SPSS V17.0 [11].

Results

A total of 1,186 adult asthmatic patients that were seen, at least once, between February and November 2010, were included by a total of 102 allergists all over the country. Out of the whole sample, 1,098 asthmatic patients (92.6%) were eligible for including in the statistical analysis;

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58.7% were females with 41.2 (13.6) years on average. The patients were evenly distributed regarding geographical location and seasonality (February–March, April-July, and August-September). No relevant differences regarding the season of the year and/or geographical locations were observed. According to the ACT score **(table 1),** 57.6% had not controlled, 32.8% partially controlled, and 9.6% totally controlled asthma. Season, age or severity of asthma symptoms as determined by the GINA/GEMA classification were not significantly associated with summary sleep index problems (data not shown). However, when age was grouped into younger patients (18 to 40 years) versus older ones (>40 years), then significant, although moderate differences, were observed in the summary sleep index problem, with better score in younger than in older patients (29.1 points versus 37.5), respectively ($p<0.05$). By gender, statistical significant differences were also observed in most MOS-sleep scale domains **(figure 1),** but only in two domains (quality ($p<0.01$) and short of breath ($p<0.05$) by smoking habit. Means were adjusted by covariates age (years), gender, GEMA/GINA classification and score in Asthma Control Test

Severity of asthma, as classified by the GINA/GEMA classification, was significantly associated with negative impact of the disorder into all domains of sleep and general index sleep problems as well (**table 2)**: the higher the severity of asthma the higher the adjusted mean interference in the domain or composite score, except for snoring domain which showed a trend toward statistical significance only. Of particular interest, subjects with severe asthma sleep 0.4 hours less, on average, than patients with intermittent asthma. Along with sleep quantity, which statistic was the highest in value meaning most differences between severity groups, the composite score and sleep disturbance domain were the most impacted scores by severity of asthma. As might be expected, the quality of sleep decreased as there was an increase of the degree of severity of the illness **(table 2).** On the other hand, and paying attention on the level of asthmatic symptoms control according with the scoring in the ACT scale, the degree of control was also significantly associated with negative impact of the disorder into all domains of sleep and general index sleep problems as well (**table 3).** Again, the poorer the level of asthma symptoms control the higher the adjusted mean interference in the domain or composite score, without exception. In fact, the degree

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of symptoms control showed highest values in the statistic meaning that highest different in sleep quality, quantity or disturbance could be found according with the level of symptoms control. In this sense, subject with symptoms not controlled or partially controlled had higher scores in all the domains of the MOS-sleep scale (**table 3**). The sleep interference was also associated with the level of disability as measured by the SDI scale (**table 4**). Again, the higher the level of disability, the higher the adjusted mean interference in the domain or composite score, without exception. In fact, there was observed a clear lineal relationship between categories of disability and the degree of sleep disturbance or domains without exception. Values of the F statistic were high and all of them $p<0.001$ (**table 4**). Educational level was also significantly associated with sleep disturbances in the MOS-sleep scale; patients with no education showed significantly worse scoring in the summary score as a consequence of poor scores in sleep disturbance, snoring and daytime sleepiness domains. Means were adjusted by covariates age (years), gender, tobacco consumption GEMA/GINA classification and score in Asthma Control Test

The multivariate regression model applied to estimate the association of various determinants and the summary sleep disturbance score on the MOS-sleep scale showed that gender was a variable significantly associated (determinant) with summary index sleep score **(table 5).** The regression model fitted showed a moderate but significant adjustment: Adjusted $R^2=0.506$ ($p<0.001$), with the mentioned gender, educational level, exposition to occupational inhaled irritants and, particularly, the score in the ACT test and the degree of disability (daytime patient functioning) as measured by the SDI scale. Also, the perceived stress and familial support, as determined by the SDI, were factors related with sleep disturbances in the summary index of the MOS-sleep scale. Asthmatic patients due to occupational exposition to irritants and low educational level were less affected in their sleep problems, although showed statistical associations in the fitted model. Main determinants, as stated by their relatives weighted in the model, were the mean score in the disability scale (SDI), ACT test and perceived stress by subject.

Discussion

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The relationship between asthma and sleep disorders, including risk for apnea, poor quality of sleep and other sleep disturbances, has been documented previously by many studies [12-16]. However, although disturbed sleep is an outcome in patients with asthma, there were relatively few data on the relationship between global sleep quality and quantity, asthma control and patient functioning during daytime, particularly on a clinical routine basis. Thus, in our study we tried to describe the patient-self perceived sleep quality and quantity in subjects with asthma in a real-world setting according to different determinants of patient health status. According with our findings, several determinants were found to be statistically associated with the summary sleep disturbance score on the MOS-sleep scale, that is showing how the health status of the individual negatively impact on subject quantity and quality of sleep, and the association was meaningful (adjusted R^2 =0.506; p<0.001). Amongst the determinants found associated, daytime functioning as assessed with the SDI scale [6] was found the factor with higher ability (t=8.24) to explain the impact of daytime disability on the level of sleep disturbance; an increase of 0.7% in the patient´s disability (0.2 points in a scale ranging from 0 to 30) produces an increase of 1% in sleep disturbance. Or in other words; a 7% increment in disability is associated with a 10% of impact in sleep disturbance. It is also noteworthy, that the level of asthma control (as assessed with the ACT instrument [5, was also a meaningful determinant (t=-8.18) showing that a decrease of 0.9 point in the asthma control produces an increase of 1% disturbance in sleep. Surprisingly, the severity of asthma was not an explicative determinant of sleep disturbance despite its observed association in the univariate analysis, meaning that it seems to have greater impact in sleep disturbance to have the asthmatic symptom under control regardless of the severity of asthma. A possible explanation would be that patients with poor controlled asthma take a longer time to fall asleep [17]. Another one is that adult asthmatic patients had slightly lower sleep efficiency and a higher number of nocturnal awakenings [13,14]. In our study, gender was significantly associated with summary index sleep score. Surprisingly, one of the sleep domains, snoring, was more frequent in female patients. Snoring is a sleep-related breathing disorder and happens, in at least, 20% of the population and around half of the male populations of 50 years old [16]. This may be caused by an

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increase in upper airway suction pressures during active asthma and consequently to snoring. Other mechanisms by which there could be a relation between asthma and snoring could be gastroesophageal reflux draw by snoring may also activate asthma, or because asthmatics patients tend to have upper airway inflammation, predisposing them to snoring [17]. Familial support was inversely associated with sleep impairment, meaning that those subjects with more help at familial level could have better sleep scores, or lower impairment. By opposite, perceived stress was consequently related with sleep impairment, increasing sleep disturbance with more perceived stress. Educational level was also significantly associated with sleep disturbance; the high the educational level the lowest the impairment in sleep. This might be the consequence of poorer management of aerosol delivery devices that could be related with lack of adequate education or difficulties in understanding properly the management of drug supplier in asthma as it has been observed previously [18-19]. The fact that in our sample, subject without studies or with primary educational level had significantly lower scoring in the ACT scale could support such affirmation. Finally, exposition to irritant was left in the model because was considered a confounding variable since no significant differences were observed neither in the summary index score nor in any of the domain of the MOS-sleep scale (data not shown).

On the other hand, although not strongly associated, our study was able to show the negative influence of smoking on quality of sleep in these asthmatic subjects, and also that awakening, short of breath was more impaired in smokers than in non-smokers. This is because smoking increased the risk of airway obstruction in adult subjects with asthma onset after age 10 years [20]. This is of relevance, since smoking is one of the risk factors influencing the therapeutic response to corticosteroids, and thus, poor asthma controlled [21].

The results of our study focussing on the quality and quantity of sleep and the level of impairment in adult asthmatic by using a self-administered questionnaire are of relevance considering that there are few papers in the scientific literature covering such an approach. Actually, we found two works using the MOS-sleep scale in asthmatic patients only; one was a national survey of allergic rhinitis in a French adult population based-sample [22], and the other

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one was a part of a clinical trial comparing budesonide and formoterol in moderate to severe subjects with asthma [23]. The MOS-sleep scale is a self and easy to be administered questionnaire which its use can be implemented in the primary care level without overloading the work of either physicians or nurses but obtaining very important information). It is true that in our study sleep was assessed by a self-reported scale, not by a polysomnographical analysis, which may not be completely accurate. As we know polysomnografy is still the gold standard for sleep disturbances, due to be a costly method population, questionnaire-based studies, as the one included here may have several constraints or considered limited Nonetheless, polysomnografy or other instrumental methods exploring sleep status are not feasible to all clinician on a routine medical basis and in such circumstances is when easy ways to explore sleep status may be of help.

Although our study was able to enrol a large sample of subjects with asthma, nationwide representative, and thorough different seasons of the year, thus, capturing the possible impact of seasonality on symptoms control and/or patient functioning, we must address several possible limitations. For example, co-morbidities were not registered in the study and they may have effects on sleep and sleepiness such as obesity, rhinitis, gastro-oesophageal reflux or drug side effects. Other limitation is that we explore daytime functioning by means of, again, a self-administered questionnaire, as the SDI scale, that is not only a self-administered questionnaire but also may be considered too simple to capture patient functioning as a whole. However, this scale has been used by other investigators previously, in different health conditions, with the same objective; just to try capture, in a simple fashion, how health status impact on daily functional activity [24].

Despite possible limitations, we may conclude that this large cross-sectional, observational, seasonal-waves survey study found a relationship between sleep quality and quantity and the degree of asthmatic symptoms control, and that, in addition to gender, educational level , smoking status and, disability on daytime functioning are significant determinants of sleep disturbance in adult asthmatics. A better control of nocturnal asthma symptoms could lead to improved sleep quality and a decrease in daytime sleep-related symptoms and, perhaps disability.

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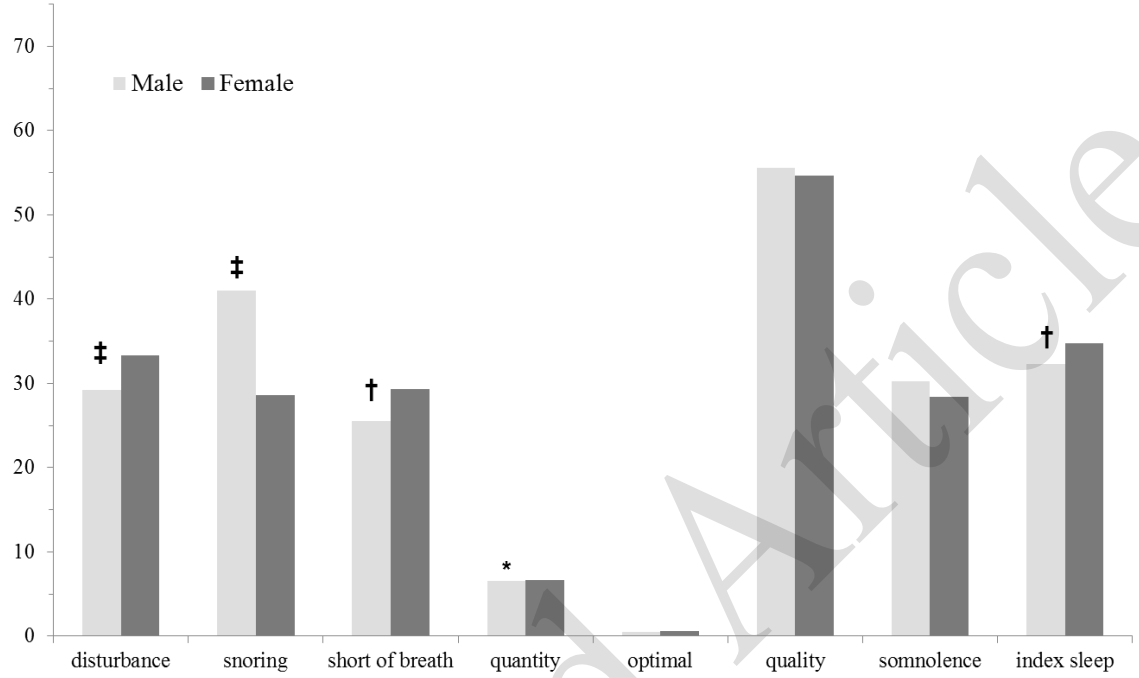
Figure 1. Mean scores in MOS-sleep scale general sleep index and domains by gender.



Footnote: Differences significant at ‡ $p<0.001$, † $p<0.01$; *$p<0.05$ versus female. Means are adjusted by covariates age (years), GEMA/GINA classification; tobacco consumption and score in Asthma Control Test.

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Table 1. Demographic and baseline clinical characteristics of patients (n=1,098).

Age (years), mean (SD)	41.2 (13.6)
Sex (female), n (%)	628 (58.7%)
Body mass index (kg/m^2), mean (SD)	25.6 (4.0)
Educational level, n (%)	
No education	44 (4.1%)
Elementary education	314 (29.3%)
Secondary education	425 (39.7%)
Higher education (college)	287 (26.8%)
Work status, n (%)	
Active	360 (33.3%)
Housewife	157 (14.5%)
Administrative assistant	89 (8.2%)
Teacher	82 (7.6%)
Retired	13 (1.2%)
Does not work (student)	94 (8.7%)
Other	287 (26.5%)
Asthma severity, n (%)	
Intermittent	274 (25.1%)
Mild	294 (26.9%)
Moderate	299 (27.4%)
Severe	226 (20.7%)
Asthma control by Asthma Control Test (ACT) scale, n (%)	
Fully controlled (>25)	105 (9.6%)
Controlled (≥19-24)	360 (32.8%)
Partially controlled (>15<19)	264 (24.1%)
No controlled (≤15)	367 (33.4%)
Causes of asthma n (%)	
Allergies	820 (75.2%)
Infections	573 (52.5%)
Exercise	425 (39.0%)
Humidity and cold weather	390 (35.7%)
Smoking habits	337 (30.9%)
Stress	270 (24.7%)
Other	31 (2.8%)

Table 2. Patient-reported MOS-Sleep scale indexsleep problems and domains by level of asthma severity according to the GINA/GEMA classification

MOS sleep domain	Intermittent (n=262)	Mild persistent (n=279)	Moderate persistent (n=281)	Severe (n=209)	F	P value
Sleep disturbance (0-100)	30.3 (27.8, 32.9)	28.0 (25.8, 30.2)	31.4 (29.2, 33.7)	38.1 (35.2, 40.9)	9.6	<0.001
Snoring while sleeping (0-100)	30.1 (26.3, 33.9)	31.8 (28.5, 35.1)	36.0 (32.7, 39.4)	36.7 (32.5, 40.8)	2.1	0.093
Awakening Short of breath (0-100)	26.6 (23.7, 29.5)	24.9 (22.4, 27.4)	27.9 (25.3, 30.4)	32.4 (29.2, 35.6)	4.1	0.007
Sleep quantity (0-24)	6.8 (6.7, 7.0)	7.0 (6.8, 7.1)	6.6 (6.5, 6.7)	6.4 (6.2, 6.5)	10.9	<0.001
Optimal sleep (0-1)	0.58 (0.51, 0.64)	0.62 (0.57, 0.68)	0.51 (0.46, 0.57)	0.46 (0.39, 0.50)	4.5	0.004
Sleep quality (0-100)	56.7 (53.4, 60.1)	59.0 (56.1, 61.9)	53.4 (50.5, 56.4)	49.8 (46.1, 53.5)	4.7	0.003
Daytime sleepiness (0-100)	26.6 (24.0, 29.2)	27.4 (25.2, 39.6)	29.7 (27.5, 32.0)	33.8 (30.9, 36.7)	4.4	0.005
General indexsleep problems (0-100)	33.0 (31.2, 34.8)	31.4 (29.9, 33.0)	33.3 (31.8, 34.9)	38.4 (36.5, 40.4)	9.9	<0.001

Mean values with 95% confidence interval. P values adjusted for age, gender, smoking habits and degree of asthma symptom control on ACT (Asthma Control Test) scale.

Table 3. Patient-reported MOS-Sleep scale indexsleep problems and domains by level of asthma symptom control according to ACT score.

MOS-Sleep domain	Uncontrolled (n=367)	Partially controlled (n=265)	Controlled (n=360)	Full controlled (n=105)	FF (Pvalue)
Sleep disturbance (0-100)	45.4 (42.1, 47.7)	30.3 (28.1, 32.6)	22.8 (19.9, 24.2)	20.7 (17.0, 24.4)	65.1 (<0.001)
Snoring while sleeping (0-100)	44,9 (41.5, 48.3)	31.2 (27.8, 34.6)	26.3 (23.1, 29,4)	25.7 (20.3, 31.2)	19.1 (<0.001)
Awakening short of breath (0-100)	47.7(45.2, 50.3)	26.0 (23.4, 28.5)	13.8 (11.5, 16.2)	12.0 (7.8, 16.1)	109.0 (<0.001)
Sleep quantity (0-24)	6.2 (6.1, 6.3)	6.8 (6.7, 6.9)	7.0 (6.9, 7.1)	6.8 (6.5, 7.0)	21.8 (<0.001)
Optimal sleep (0-1)	0.37 (0.31, 0.42)	0.59 (0.53, 0.65)	0.67 (0.60, 0.70)	0.66 (0.57, 0.75)	17.2 (<0.001)
Sleep quality (0-100)	41.3 (38.2, 44.3)	55.2 (52.2, 58.2)	65.3 (62.5, 68.1)	65.0 (60.1, 69.8)	38.0 (<0.001)
Daytime sleepiness (0-100)	38.3 (35.9, 40.6)	26.9 (24.6, 29.2)	23.5 (21.3, 25.6)	23.5(19.7, 27.2)	26.1 (<0.001)
General index sleep problems (0-100)	44.6 (43.0, 46.2)	32.6 (31.1, 34.2)	26.4 (25.0, 28.0)	25.3 (22.7, 27.8)	81.2 (<0.001)

Mean values with 95% confidence interval. ACT=Asthma Control Test. P values adjusted for age, gender, smoking habits and asthma severity based on the GINA/GEMA criteria.

Table 4. Patient-reported MOS-Sleep scale index sleep problems and domains by level of disability according to SDI score.

MOS-Sleep domain	Intermittent (n=322)	Mild (n=442)	Moderate (n=184)	Severe (n=135)	F (P value)
Sleep disturbance (0-100)	22.8 (20.6, 25.1)	30.5 (28.9, 32.2)	38.9 (36.2, 41.6)	47.2 (43.6, 50.8)	36.1 (<0.001)
Snoring while sleeping (0-100)	27,2 (23.7, 30.8)	33.0 (30.4, 35.6)	38.3 (33.9, 42,6)	44.9 (39.1, 50.6)	7.2 (<0.001)
Awakening short of breath (0-100)	21.5 (18.9, 24.0)	27.5 (25.6, 29.4)	32.2 (29.1, 35.3)	38.3 (34.2, 42.4)	12.8 (<0.001)
Sleep quantity (0-24)	6.9 (6.7, 7.0)	6.8 (6.7, 6.9)	6.7 (6.5, 6.8)	6.2 (5.9, 6.4)	8.1 (<0.001)
Optimal sleep (0-1)	0.69 (0.63, 0.75)	0.57 (0.53, 0.61)	0.41 (0.33, 0.48)	0.35 (0.25, 0.44)	12.6 (<0.001)
Sleep quality (0100)	64.5 (61.5, 67.6)	55.3 (53.0, 57.5)	45.7 (41.9, 49.4)	42.6 (37.6, 47.5)	19.5 (<0.001)
Daytime sleepiness (0-100)	22.4 (20.1, 24.7)	28.7 (27.0, 30.4)	31.6 (28.8, 34.5)	44.1 (40.3, 47.9)	23.8 (<0.001)
General index sleep problems (0-100)	27.5 (25.9, 29.0)	33.1 (32.0, 34.2)	38.3 (36.4, 40.1)	45.6 (43.1, 48.0)	40.0 (<0.001)

Mean values with 95% confidence interval. ACT=Asthma Control Test. P values adjusted for age, gender, smoking habits, ACT score and asthma severity based on the GINA/GEMA criteria.

Table 5. Determinants associated with MOS-Sleep scale index sleep problems in subjects with asthma.

Variable	**ß coefficient** (SE)	Sig.	t
Sex	1.99 (0.72)	**0.006**	2.75
Educational level	-1.33 (0.44)	**0.003**	-3.01
Occupational exposure to irritants	-3.03 (1.20)	**0.012**	-2.53
ACT score	-0.89 (0.11)	**<0.001**	-8.18
Disability score (SDI)	0.21 (0.03)	**<0.001**	8.24
Familial support (SDI, item #4)	-0.04 (0.01)	**<0.001**	-3.56
Perceived stress (SDI, item #5)	0.10 (0.02)	**<0.001**	5.01

Adjusted R^2=0.511 ($p<0.001$); SE=Standard error; SDI= Sheehan Disability Index; ACT=Asthma Control Test.