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Abstract

Background: Sleep is a significant dimension of daily life. However, only a few studies have examined the sleep quality of asthmatics in a real-world clinical settings.

Objective: This study is aimed to estimate the prevalence of sleep impairments among asthmatic patients and examine the relationship between sleep quality, asthma control, rhinitis symptoms, and sociodemographic characteristics.

Methods: The present study adopted the observational cross-sectional research design that has been designed by the Italian Respiratory Society and used valid assessments to measure the study variables.

Results: Data from 1150 asthmatic patients (mean age 51.01 years $\pm$ 16.03) were subjected to analysis. 58.3% of the patients had impaired sleep quality (Pittsburgh Sleep Quality Index [PSQI] total scores > 5), and their mean PSQI score was 5.68 (SD = 3.4). A significant correlation emerged between sleep quality and asthma control ($p = 0.0001$) and a significant albeit weak correlation emerged between PSQI total scores and Total 5 Symptoms Score ($r = 0.24$, $p = 0.0001$). Sleep

quality was significantly associated health-related quality of life [HRQoL]. ($r = 0.50$, $p < 0.001$). After exclusion of patients at risk for Obstructive Sleep Apnea Syndrome (OSAS) and Gastro Esophageal Reflux Disease (GERD), the most important determinants of PSQI score were HRQoL. In the entire sample asthma control is the strongest predictor of both sleep quality and HRQoL.

Conclusions: The results of this real-world study highlight the prevalence, impact and predictors of sleep disturbances in asthmatic patients and suggest the need for physicians to detect poor sleep quality

Key words: asthma, sleep, rhinitis, sleepiness, reflux, quality of life

Introduction

Similar to asthma symptoms, rhinitis symptoms (1), which are experienced by 80% of asthmatic patients (2-6), impact quality of life. The well-known impact of these diseases on sleep is a part of disease control and assessment of quality of life (7).

Uncontrolled asthma leads to sleep impairment (8), while the pathogenetical features of asthma (i.e., bronchial obstruction) are worsened by sleep (9). Further, allergic rhinitis affects the quality of sleep and the presence of nocturnal symptoms and awakening is considered to determine the disease severity (10). Past research has underscored the impact of rhinitis symptoms on all aspects of sleep quality and consequently on a patient's quality of life (11). Concomitant asthma and rhinitis can influence each other; therefore, they should be accurately diagnosed and treated accordingly (8). Within this complex framework, it is also important to note that other common diseases such as Gastro Esophageal Reflux Disease [GERD and Sleep Apnea Syndrome [OSAS] (12) are often associated with asthma and rhinitis, which in turn can impact the quality of sleep at night.

Sleep is a significant dimension of a patient's life and the long-term interruption of normal sleeping patterns adversely affects physical and emotional functioning (13), cognitive performance (14), work productivity (15), and leisure activities (16). Moreover, among patients with chronic physical health conditions, disrupted or deficient sleep can exacerbate symptoms and disease severity (17), impair health-related quality of life [HRQoL] (18), and increase their risk for poor health outcomes (19) and psychological distress (20).

Since sleep disturbances adversely affect many aspects of functioning, accurate detection and monitoring of their manifestation is important to the management of asthma (21).

Given this contention and the relative lack of research findings in this area, we sought to provide observational evidence about the sleep quality of asthmatics and the relationships between sleep quality, patient-reported outcomes [PROs] (i.e., asthma control, rhinitis

symptoms, quality of life, daytime sleepiness, risk of OSAS, and the frequency and severity of reflux symptoms), and individual characteristics (i.e., obesity) because they have important implications for scientific inquiry and healthcare management.

Aims of the study

The primary aim of this study was to assess the sleep quality of asthmatic patients (Global Initiative for ASTHMA - GINA 1–5) with and without allergic rhinitis.

Further analysis was conducted to explore:

- the relationship that sleep quality shares with asthma control and rhinitis symptoms;
- the relationship that sleep quality shares with asthma- and rhinitis-related quality of life;
- the prevalence of risk for OSAS and GERD among the asthmatic population in order to exclude other potential causes of sleep disorder from analyses the relative influence of asthma control, rhinitis symptoms, and risk for OSAS and GERD on sleep quality and asthma- and rhinitis-related quality of life.

Method

An observational, cross-sectional, multicenter, and nationwide study was conducted across 30 specialist centers.

All smoking and nonsmoking adult (age ≥ 18 years) patients who were being treated for asthma and were present at specialist centers for a scheduled visit were invited to participate in this study. This study was approved by the ethical committee of the coordinating center (University of Genoa). After the participants provided informed consent, each participant was requested to complete 7 questionnaires during their visit, while the physician collected their demographic and clinical data. Patients who were already involved in other clinical trials or had other diseases (respiratory or ear–nose–throat disorders) that could have potentially interfered with the outcomes of the present study were excluded.

The following tools were used in the present study.

Pittsburgh Sleep Quality Index (PSQI)

The PSQI is a valid self-report measure of subjective perceptions of sleep quality and disturbances during the past month (22,23). It consists of 19 self-rated questions that are grouped into seven components: sleep quality, latency, duration, and disturbance, habitual sleep efficiency, use of sleeping medication, and daytime dysfunction. The sum of scores that are yielded by these seven components is a global measure of subjective sleep quality (range: 0–21). A total score that is ≥ 5 is indicative of poor sleep quality.

Asthma Control Test (ACT)

The ACT (24, 25) is a valid and widely used measure of the level of asthma control. This questionnaire consists of five items that assess the presence of limitations at work or school that are caused by asthma, experience of diurnal and nocturnal symptoms, use of rescue medications, and subjective perceptions of the level of asthma control during the past four weeks. Patients were required to record their responses to each item on a scale that ranged from 1 to 5. Composite scores were classified as follows: uncontrolled asthma (score = 5–19), well-controlled asthma (score = 20–24), and total disease control (score = 25) (25).

Total 5 Symptoms Score (T5SS)

Rhinitis symptoms were assessed using the T5SS, which assesses the following symptoms: nasal discharge (rhinorrhea) and congestion, an itchy nose, sneezing, and itchy eyes. All symptoms were rated on a scale that ranged from 0 (absent) to 3 (very troublesome), and the total scores ranged from 0 to 15.

Rhinasthma

The Rhinasthma is used to assess the impact of rhinitis and/or asthma on the HRQoL of patients (26). It consists of 30 items; these items yield scores for three factors, namely, upper airways (UA), lower airways (LA), and respiratory allergy impact (RAI) as well as a composite score, namely, the global summary (GS), which is an indicator of the overall impact of the disease. Patients are required to use a five-point scale (i.e., not at all, a little, fairly, much, and very much) to indicate the extent to which they were bothered by each problem during the two weeks that preceded the completion of the questionnaire. Their responses were converted into scores that ranged from 0 to 100, and higher scores were indicative of poorer HRQoL. A GS score that is ≤ 20

indicates that the disease has had minimal or no impact on a patient's life, and it is indicative of optimal HRQoL (27).

Epworth Sleepiness Scale (ESS)

The ESS (28, 29) measures daytime sleepiness during the past week. It consists of eight items that require responses to be recorded on a four-point scale (range: 0–3). The total score is the sum of the ratings for individual items (range: 0–24). A cutoff score of 10 has been suggested as an indicator of “a high level of daytime sleepiness.”

Sleep Apnea Scale

The Sleep Apnea Scale of the Sleep Disorders Questionnaire [SA-SDQ] is a valid screening instrument that can be used to identify patients who are at high risk for OSAS. It assesses eight OSAS symptoms (i.e., loud snoring that is disruptive to a bed partner, breathing pauses during sleep, sudden gasping and arousal during sleep, worsening of snoring as a result of adopting a supine position or after alcohol consumption, nocturnal nasal congestion and sweating, and a history of hypertension), and responses are recorded on a 5-point Likert scale. Four sociodemographic variables (i.e., age, smoking status, weight, and Body Mass Index (BMI) were also assessed. The proposed cutoff score for OSAS is 36 for men and 32 for women (30).

GERD Impact Scale (GIS)

The GIS is a simple, 9-item, patient- completed tool to communicate to the doctor the frequency and severity of reflux symptoms (31). The GIS was developed using a rigorous process that involved input from patients as well as doctors at several stages. The GIS was shown to have internal consistency, reproducibility, construct validity and responsiveness to change.

Statistical analysis

Descriptive statistics were computed for the quantitative variables. Group comparisons were conducted using t-test and ANOVA. Linear correlation analysis was conducted to examine the effect of the covariates on the primary outcome. Gender, age, severity of asthma (which was ascertained as per GINA guidelines: steps 1–5), type of treatment, and educational level were considered as possible prognostic factors. Their effect on the primary outcome was tested using a univariate model.

Multiple regression analysis was used to develop a model that accurately represents the relationships between the study variables. All analyses were conducted using IBM SPSS (version 25, Armonk, NY).

Results

A total of 1159 patients enrolled in this study. However, nine patients were excluded because they submitted incomplete questionnaires; therefore, analyses were conducted using the data that were obtained from a sample of 1150 patients. The mean age of the participants was 51.01 years (SD = 16.03, range = 18–91). A majority of the participants were women (60.1%), Caucasians (98%), and those with at least a high school degree (65.9%). The clinical characteristics of the patients are summarized in Tables 1 and 2.

The percentage of patients with well-controlled and totally controlled asthma was 59.8% (totally controlled: 11.5%), and 89 patients (7.7%) were at risk for OSAS and GERD.

Sleep quality

The mean overall sleep quality score was 5.68 (SD = 3.4). Further, 58.3% of the patients obtained scores that were ≥ 5 (i.e., the cutoff score). The domains that primarily contributed to the total score (i.e., worse sleep quality) were sleep disturbances, daytime dysfunctions that result from sleepiness, and overall sleep quality (Table 3).

There was no difference in PSQI scores between patients with and without allergic rhinitis ($F = 1.70$, n.s) who were diagnosed by physicians as per the ARIA guidelines. On the other hand, the severity of asthma, which was ascertained based on the GINA guidelines, was significantly associated with sleep quality ($F = 3.84$, $p = 0.004$). Specifically, patients who belonged to Stages 4 and 5, as per the GINA guidelines, obtained a PSQI mean score that was above the cutoff score that is indicative of normal sleep quality (6.55 ± 3.86 and 5.89 ± 3.45 , respectively).

Sleep quality was significantly related to asthma control ($r = 0.414$, $p = 0.0001$). Significant differences in PSQI scores emerged between groups that differed in their level of asthma control ($F = 74.39$, $p < 0.0001$) (Figure 1). The results of univariate analyses revealed that uncontrolled asthma (ACT score < 20) was associated with 3.3 times higher odds of having poor sleep quality (PSQI score ≥ 5) (95% Confidence Interval [CI]= 2.57–4.26, $p < 0.001$).

A weak but significant correlation emerged between the overall scores of the PSQI and T5SS ($r = 0.24$, $p = 0.0001$).

Sleep quality was significantly associated with GS ($r = 0.50$, $p < 0.001$) and the following dimensions of Rhinasthma: UA ($r = 0.33$, $p < 0.001$), LA ($r = 0.54$, $p < 0.001$), RAI ($r = 0.36$, $p < 0.001$), and GS ($r = 0.50$, $p < 0.001$). These relationships were observed even when the sample was confined to include only patients who were not at risk for OSAS and GERD. Specifically, sleep quality was associated with UA ($r = 0.31$, $p < 0.001$), LA ($r = 0.51$, $p < 0.001$), RAI ($r = 0.32$, $p < 0.001$), and GS ($r = 0.47$, $p < 0.001$). Poor HRQoL (Rhinasthma: GS score < 20) was associated with 4.74 times higher risk for poor sleep quality (PSQI score ≥ 5) (95% CI = 3.67–6.41, $p < 0.001$).

After exclusion of patients at risk for OSAS and GERD, multiple regression analysis was conducted to examine the relative influences of eleven independent variables on sleep disturbance. 30.8% of the variance was explained by seven variables (Table 4).

The relative influence of asthma control, rhinitis symptoms, risk of OSAS and GERD on sleep quality and on HRQoL was evaluated by mean of multiple regression analyses in the entire sample. The adjusted R-squared value was 0.260 for PSQI and 0.629 for HRQoL; this indicates that 26% and 62.9% of their variances were explained by the four independent variables. ACT scores was the strongest predictor of the PSQI score ($\beta = -.288$, $p < 0.001$) followed by GIS scores ($\beta = -.215$, $p < 0.001$) and T5SS ($\beta = -.288$, $p < 0.001$). ACT resulted to be the strongest predictor also for HRQoL scores ($\beta = -.463$, $p < 0.001$) followed by T5SS ($\beta = .388$, $p < 0.001$) and GIS ($\beta = -.136$, $p < 0.001$). SASDQ failed to predict both PSQI and Rhinasthma scores.

Discussion

Although sleep impairments that are caused by asthma are a hallmark feature of uncontrolled diseases and/or their severity, the existing literature on this topic is scant. Therefore, our aim was to assess the sleep quality of asthmatic patients, residual disease burden, and concomitant or comorbid disorders that are associated with sleep impairment. Our study was conducted in a real-world clinical setting, using a large sample of asthmatic patients who had been treated according to GINA guidelines. Sleep quality and other PROs were assessed using valid questionnaires.

Sleep disturbance was found to be a common problem among patients with asthma. Specifically, 58.3% of the participants met the criteria for poor sleep quality.

PSQI scores were related to the severity of asthma (which was defined in accordance with the treatment that was required for disease management) and level of asthma control. Patients with

uncontrolled asthma were three times more likely to have sleep impairments than their counterparts with controlled asthma.

Sleep impairment was also associated with rhinitis symptoms. PSQI scores were significantly and inversely related to the composite (GS) and three factor scores that are yielded by the Rhinasthma, which was used to assess asthma- and rhinitis-related HRQoL. This result is consistent with past findings that sleep quality affects HRQoL (32,33). In patients without risk for OSAS and GERD the most important determinants of PSQI score were HRQoL, GIS score and ACT. In the entire sample, asthma control was the most important determinant of both sleep quality and HRQoL.

The results of our study highlight the prevalence, predictors, and impact of sleep disturbances on the HRQoL of patients with asthma. The findings paint a complex portrait of the relationships that sleep quality shares with disease severity and control. Further, the findings suggest that sleep quality can be predicted based on the level of asthma control and presence of comorbid conditions.

Since an observational cross-sectional research design was used in this study, causal inferences about the emergent relationships cannot be drawn. Patients selection bias cannot be excluded since the patients were recruited only across 30 specialist respiratory centers. Furthermore, it was not possible to examine all the pathologies and clinical features that interfere with sleep quality.

Despite these limitations, the results of this large observational cross-sectional study have highlighted the prevalence of sleep impairments among patients with asthma and their relationship with the level of asthma severity and control and HRQoL. Although future studies that examine a wider range of variables are needed, the present results underscore the need for physicians to detect poor sleep quality among their patients. An increased attention to assessment of sleep disturbances may help to drive choices and interventions for the achievement of asthma outcomes. Better sleep quality can improve asthma control and minimize the impact of asthma on HRQoL and the achievement of asthma control would eliminate night awakenings and decrease the daytime sleep-related problems.

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Declaration of interest statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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Table	1.	Clinical features of the sample
		Percentages
Asthma (GINA class)	1	10.7
	2	29.4
	3	34.4
	4	16.7
	5	8.8
Allergy	Yes	77
Rhinitis	Persistent	31.7
	Intermittent	47.5
	No	20.8
Smoking	Non smoker	62. 6
	Smoker	28.2
	Ex smoker	9.2

Legenda: GINA: Global Initiative for Asthma

Table 2. Population clinical variables

	<i>M(SD)</i>
Neck circumference	37.49(4.17)
BMI	26.76(5.46)
FEV1	85.59(20.6)
PSQI	5.68(3.4)
ACT-TOT.	19.68(4.5)
RHINASTHMA TOT.	20.66(15.64)
T5SS-TOT.	5.22(3.8)
ESS-TOT.	5.44(4.16)
SA-SDQ	69.44 (18.16)
GIS	4.37 (0.57)

Legenda: BMI = Body Mass Index; FEV1= Forced expiratory volume in the first second; PSQI= Pittsburgh Sleep quality Index; ACT= Asthma control test; Rhinasthma= Rhinasthma total score; T5SS = total 5 symptoms score; ESS= Epworth Sleep Scale; SA-SDQ= Sleep Apnea Scale of the Sleep Disorders Questionnaire; GIS= GERD Impact Scale.

Table 3. PSQI domains and total scores

	<i>M (SD)</i>
Sleep Duration	.82 (.97)
Sleep Disturbance	1.31 (.61)
Sleep Latency	.94 (.94)
Daytime Dysfunction	1.17 (.80)
Habitual Sleep Efficiency	.19 (.72)
Sleep Quality	1.09 (.79)
Use of Sleeping Medication	.29 (.83)
<i>PSQI Total Score</i>	5.68 (3.4)

Legenda: PSQI= Pittsburgh Sleep Quality Index

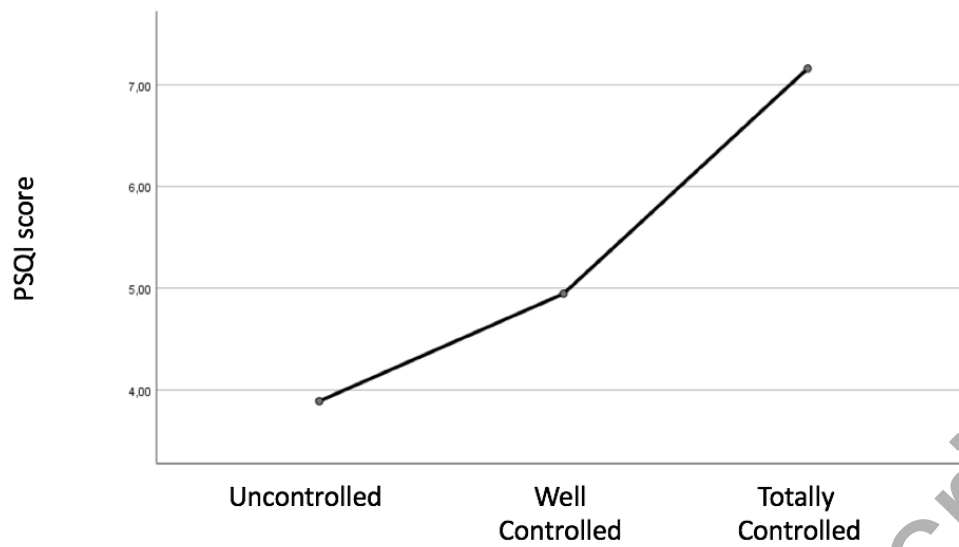
Table 4 . Multiple Linear Regression Analyses Results Related to PSQI scores and RHINASTHMA Global Summary

*p<.05, **p<.01

Dependent Variable	Indipendent Variables	B	Standard Error	β	t	p	Tolerance	VIF
PSQI	Constant	6,669	1,777		3,754	,000		
	Age	,013	,017	,065	,774	,439	,200	4,991
	BMI	,054	,024	,091	2,244	,025	,858	1,165
	FEV1 %	,005	,006	,035	,864	,388	,878	1,139
	ACT	-,091	,039	-,120	-2,358	,019	,545	1,835
	T555	-,019	,044	-,021	-,432	,666	,601	1,664
	Rhinitis	,075	,165	,018	,455	,649	,922	1,084
	Rhinasthma GS	,074	,014	,346	5,500	< 0.001	,357	2,798
	GIS	-,968	,268	-,155	-3,612	< 0.001	,768	1,302
	SASDQ	,003	,016	,016	,186	,853	,189	5,303
	MMAS	-,093	,116	-,031	-,801	,423	,921	1,086
	EES	,064	,033	,079	1,957	,051	,857	1,167

Legenda: Legenda: BMI = Body Mass Index; FEV1= Forced expiratory volume in the first second; PSQI= Pittsburgh Sleep quality Index; ACT= Asthma control test; T5SS = total 5 symptoms score; Rhinasthma GS= Rhinasthma global score; GIS= GERD Impact scale; ESS= Epworth Sleep Scale; SASDQ= Sleep Apnea Scale of the Sleep Disorders Questionnaire; GIS= GERD Impact Scale.

Figure 1. PSQI score in the 3 levels of asthma control. (*) Significantly higher scores ($p < 0,001$)



Legenda: PSQI= Pittsburgh Sleep Quality Index

Uncontrolled= Asthma control test (ACT) <20

Well controlled= ACT 20-24

Totally controlled ACT 25