

# Allergic Rhinitis and Its Consequences on Quality of Sleep

## An Unexplored Area

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**Background:** Allergic rhinitis (AR) is common and has been shown to impair social life and sleep. Patients with severe symptoms may have more sleep disturbances than those with a mild form of the disease, but this has never been assessed using a validated tool. The objective of our study was to assess, in patients with AR, whether duration and severity of AR are associated with sleep impairment.

**Methods:** A nationwide controlled cross-sectional epidemiological study was carried out. A representative sample of 260 French ear, nose, and throat and allergy specialists enrolled 591 patients with AR of at least 1 year's duration. Sleep disorders, sleep quality, and AR were assessed using validated tools (Sleep Disorders Questionnaire, Epworth Sleepiness Scale, and Score for Allergic

Rhinitis). The severity of AR was assessed using the Allergic Rhinitis and its Impact on Asthma classification.

**Results:** All dimensions of sleep were impaired by AR, particularly by the severe type. Sleep was significantly more impaired in patients with severe AR than in those with the mild type. The duration of AR (intermittent or persistent) had no effect on sleep.

**Conclusion:** These data underline the close relationship between AR and sleep and highlight the need for clinicians, particularly general practitioners, to be attentive in this respect.

*Arch Intern Med.* 2006;166:1744-1748

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**A**LLERGIC RHINITIS (AR) IS A common condition that affects, on average, 20% to 50% of the general population.<sup>1</sup> Sleep disorders are also very common in the general population. Insomnia affects from 20% to 30% of adults, and severe insomnia about 10% of adults.<sup>2-4</sup> Sleep apnea was objectively found in 9% of women and 24% of men, and hypersomnia, defined as the occurrence of episodes of sleepiness during daily life, affects 4% to 6% of the general population in its severe form and from 15% to 20% in its moderate form.<sup>5</sup>

Allergic rhinitis has been shown to impair quality of life, according to generic tools such as the Short-Form 36-Item Health Status questionnaire,<sup>6-8</sup> or more disease-specific tools, such as the Rhinconjunctivitis Quality of Life Questionnaire.<sup>9</sup> Sleep disorders have an impact on patients' quality of life. According to the affected patients, the most important problems related to their condition are the impairment of sleep quality and its consequences, such as daytime sleepiness and impaired concentration.<sup>10</sup> Several studies<sup>11-14</sup> have shown the relationships among

AR and nasal obstruction and abnormal breathing during sleep, snoring, and sleep apnea. In a European cross-sectional survey<sup>15</sup> that investigated the prevalence of sleep disturbances and daytime sleepiness, a positive relationship was found between asthma and daytime sleepiness and apnea; among asthmatic patients, 71% also had AR, which was found to be independently related to increased difficulty in falling asleep, and daytime sleepiness. Poorly controlled symptoms of AR may also contribute to sleep loss or disturbance,<sup>12-14</sup> resultant daytime fatigue, and decreased overall cognitive functioning. Insomnia also needs to be considered, and, surprisingly, we could not find any study that specifically addressed the epidemiology of sleep disorders in patients with AR. Allergic rhinitis and sleep disorders are therefore 2 prevalent complaints in the general population, and data on their co-occurrence is accumulating. Yet, to our knowledge, there has been no attempt to explore this link.

Therefore, we conducted the DREAMS (*Étude Descriptive des RhinitEs Allergiques et des Modifications du Sommeil* [Descriptive Study of Allergic Rhinitis and

Sleep Impairment]) to assess the importance of sleep impairment in AR according to its severity and duration.

## METHODS

The DREAMS was a controlled cross-sectional study performed with a sample of patients with AR who were being treated by an allergist or ear, nose, and throat specialist. The description of the study and the characteristics of the patients have been published previously.<sup>16</sup> The participating clinicians were randomly selected from the overall population of their respective specialization in France. These specialists were selected from all regions of France to rule out any geographic or seasonal parameter and to take into account the population distribution in the country (stratification for geographical area). Each clinician had to include the first patients (at least 2 patients) who presented with AR and who met the inclusion criteria.

This study was approved by the national authority for epidemiological database studies (Commission Nationale Informatique et Liberté), and under the French regulatory system, individual consent was not required for this kind of study.

## SUBJECTS

Inclusion criteria were that patients—men or women—had to be aged 18 to 50 years, have AR of at least 1 year's duration, and have a score of 7 or higher on the self-administered Score for Allergic Rhinitis questionnaire (see the following subsection).<sup>17</sup> Exclusion criteria were the presence of grade III or IV nasal polyps and/or major nasal septum deviation.

A control group of individuals without AR was matched for age, sex, and geographical area with the first 2 patients selected by the physicians. They were selected from among men and women who were being treated at general practitioners' clinics.

## ESTABLISHING AR

The Score for Allergic Rhinitis is a validated diagnostic tool.<sup>17</sup> A score of 7 or greater, the threshold used in the study described herein, has been shown to provide satisfactory discrimination between patients with AR and those without AR.<sup>17</sup> The Score for Allergic Rhinitis questionnaire was completed by patients, and a score was assigned by the clinician. Clinicians completed a standardized questionnaire that covered demographics (their own and those of their patients) and patient characteristics.

Information recorded for each patient included the following: socioeconomic status category, smoking habits, type of AR (according to the Allergic Rhinitis and Its Impact on Asthma [ARIA] classification), symptoms and duration of AR, concomitant allergic disorders (ie, previously diagnosed), therapeutic treatment of patients with AR, and ongoing treatment of concomitant diseases (responses included use of anxiolytic drugs, hypnotics, antimigraine agents, and nonsteroidal anti-inflammatory drugs).

The recently developed ARIA classification of AR was first proposed by the World Health Organization in 1999<sup>18,19</sup>; ARIA classifies AR according to the duration of the episodes (eg, intermittent or persistent) and their severity in terms of symptoms and quality of life (mild or moderate to severe).

## ASSESSMENT OF SLEEP

Sleep disorders and sleepiness were assessed by self-administered questionnaires: the Sleep Disorders Questionnaire, French version (known as Hotel Dieu-42 [HD-42]), and the Epworth Sleepiness Scale score. The HD-42 is a 42-item questionnaire based on the Stanford Sleep Questionnaire and Evalu-

Items Used to Define Sleep Disorders	Criteria for Defining Sleep Disorders
Item A How many minutes does it take for you to fall asleep? (response: >30 min)	Criterion 0 At least 1 yes to the question, "Do you have sleep problems?"
Item B How many times do you wake up each night? (response: ≥2)	Criterion 1 Items (A or B) and (C and D)
Item C "Once I wake up, I cannot fall asleep." (response: every night or every week)	Criterion 2 Duration of Sleep Disorder Longer Than 1 Month
Item D "After a normal night's sleep, I feel..." (response: a bit tired or very tired)	Criterion 3 Items E or F
Item E "I fall asleep during the day, during work, while listening to the radio or music, while traveling, in front of the TV." (response: every night/every week)	Criterion 4 Regular Use of Sedatives
Item F Does it seem that your memory has suddenly gotten worse? (response: yes)	Criterion 5 Hypersomnia: Items E or G
Item G Epworth Sleepiness Scale score >10	Criterion 6 Sleep Apnea Syndrome: Items E, H, and I
Item H Has anyone ever told you that you snore loudly? (response: yes)	Criterion 7 Stop Breathing for Several Seconds During Sleep
Item I Do you snore? (response: often or almost every day)	Criterion 8 Insomnia: Criteria 0 and 1 and Criterion 2 or 3  Criterion 9 Severe Insomnia: Criteria 0-3 or Criteria 4  Criterion 10 Observed Apnea and Sleepiness: Criterion 7 and Item E

**Figure 1.** Definition of sleep disorders. Criteria for defining sleep disorders were based on the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Revised*,<sup>24</sup> and the *International Classification of Sleep Disorders*<sup>23</sup> classification criteria. Items A to H were compared with these criteria to assess minimum criteria for the most common sleep disorders (criteria 5-10). For methods, see Léger et al.<sup>4</sup>

ation of Wakefulness.<sup>20</sup> The French version has been validated in several epidemiological studies.<sup>21,22</sup> It covers sleep habits; sleep disorders; alertness during the daytime; and psychobehavioral items on mood, memory, and sexual behavior.

Sleep disorders were defined using the categories *items* and *criteria* as shown in **Figure 1**. All but 1 of the items are derived from questions and possible responses in the HD-42. The selection of sleep disorders was based on 2 reference documents: the *International Classification of Sleep Disorders*<sup>23</sup> and the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Revised (DSM-IV-R)*.<sup>24</sup>

The HD-42 also collected data on 5 specific sleep complaints: difficulties in falling asleep, frequent nocturnal awakenings, early awakenings, poor-quality sleep, and feeling a lack of sleep. The sleep complaints are essentially drawn from the DSM-IV-R definition of insomnia. Severe insomnia was defined as the presence of at least 2 sleep complaints according to the DSM-IV-R definition. In addition, the minimum criteria from the *International Classification of Sleep Disorders* for insomnia, idiopathic hypersomnia, snoring, and sleep apnea were used. Information was also collected on duration of sleep disorders.

The Epworth Sleepiness Scale, a self-administered questionnaire, is a subjective tool constructed and tested in the early 1990s<sup>25,26</sup>; it has been validated against objective tests such as the Multiple Sleep Latency Test.<sup>27</sup>

## STATISTICAL ANALYSIS

We performed data management and statistical analysis by using the SAS software package (version 8; SAS Institute Inc, Cary, NC). Descriptive analyses for qualitative variables included number,

**Table 1. Prevalence of Sleep Complaints and Sleep Disorders According to the Type of Allergic Rhinitis (AR) (ARIA Classification)**

Complaint or Disorder	Patients With AR, %					502 Patients in Control Group*
	59 With Mild Intermittent AR	81 With Mild Persistent AR	100 With Moderate to Severe Intermittent AR	351 With Moderate to Severe Persistent AR	591 Total	
Sleep complaints						
Difficulty in falling asleep	19.6	14.6	49.5	49.6	41.6	18.3
Nocturnal awakening	14.0	15.9	53.9	51.3	42.8	20.5
Early awakening	18.2	12.4	33.3	33.2	28.7	12.8
Nonrestorative sleep	22.8	18.3	56.2	55.4	46.8	19.6
Feeling of lack of sleep	47.4	48.8	61.3	98.8	63.2	25.4
Snoring	28.1	32.5	34.0	46.0	40.3	27.1
ESS score >10	6.4	16.2	23.4	27.3	23.3	17.2
Sleep disorders						
Insomnia	14.6	14.3	40.5	42.8	35.8	16.0
Severe insomnia	10.6	10.3	27.0	27.2	23.2	10.4
Sleep apnea syndrome	1.8	1.2	0	5.8	3.8	0.5
Hypersomnia	15.6	22.7	33.7	36.9	32.6	24.3†
Other						
Regular use of sedatives	3.5	4.8	14.4	7.2	7.7	3.4†

Abbreviations: ARIA, Allergic Rhinitis and Its Impact on Asthma; ESS, Epworth Sleepiness Scale.

\*Except where noted,  $P < .001$  for total patients with AR vs control group.

† $P = .003$  for total patients with AR compared with control group.

frequency, and the 95% confidence interval, whereas quantitative variables were analyzed in terms of mean value, standard deviation, and median and extreme values. Collected data were analyzed for the total population and by subgroups of type and severity of AR (intermittent or persistent; mild or moderate to severe).

We created a logistical model for each type of sleep disturbance. A general linear model was used to study the relation between severity of AR and sleep symptoms. For description of quantitative variables, the Kruskal-Wallis test with Bonferroni-Dun post hoc analysis was used.

We determined predictive factors for sleep impairment by using logistic regression analysis after adjustment for potential confounders (sex and age). The associations were then expressed using odds ratios. A step-by-step selection of sociodemographic and clinical criteria was performed by using a univariate approach ( $\chi^2$  or Fisher exact test for nonordinal qualitative variables, Kruskal-Wallis test for ordinal data, and analysis of variance or Kruskal-Wallis test for quantitative variables).

## RESULTS

From May to September 2002, a total of 828 patients were evaluated by clinicians. Following verification of criteria, 591 of these patients, recruited by 360 clinicians, were retained for the analysis and thus constituted the DREAMS population. There were 502 subjects in the control group.

### DESCRIPTION OF THE STUDY POPULATIONS

The mean (SD) age of patients with AR (47% of whom were men) was 33.9 (9.2) years; most (77.6%) of the patients were nonsmokers. No significant difference was found between patients and the control group in sex distribution. In both populations, most subjects were living in an urban area rather than a rural area; this difference was more marked in the control group but did not reach statistical significance (78.2% vs 73.8%;  $P = .09$ ). The mean (SD) body mass index (calculated as weight in kilograms divided by height in meters squared) was

not significantly different between the 2 groups (23.6 [2.8] in patients with AR vs 24.2 [3.7] in the control group).

The only significant difference between the DREAMS population and the control group was in smoking habits (there was a higher percentage of smokers among the control group [ $P = .047$ ]) and in the socioeconomic category (a significantly lower percentage of manual workers among patients with AR [ $P < .001$ ]).

The distribution of patients with AR according to the ARIA classification shows that in this study, persistent moderate to severe AR was the most frequent type (59.4%). A total of 85% of patients with AR were receiving a treatment for their disease. Asthma was a comorbidity in 24.4% of patients with AR compared with only 1.7% of the control group ( $P < .001$ ).

### IMPACT OF AR ON SLEEP QUALITY

**Table 1** shows the prevalence of sleep complaints and sleep disorders in patients with AR (total and ARIA-classified) and the control group. Among patients with insomnia ( $n = 191$ ), the influence of the type and severity of AR on sleep complaints and disorders was analyzed; this showed a significant impact of the AR severity ( $P < .001$ ), but not of its frequency, on insomnia (**Figure 2**). In other words, patients with mild (intermittent or persistent) AR did not have insomnia more often than the control group, and only subjects with moderate to severe AR had insomnia more often than the control group. A similar finding was observed for severe insomnia ( $P < .001$ ), hypersomnia ( $P < .001$ ), respiratory arrest ( $P = .02$ ), observed apnea, sleepiness ( $P = .03$ ), and regular use of sedative agents ( $P = .009$ ) (not all data shown in **Table 2**). Compared with the control group, patients with AR reported significantly more use of sedative drugs and alcohol consumption ( $P = .003$  and  $P < .001$ , respectively).

## IMPACT OF AR ON SNORING AND APNEA

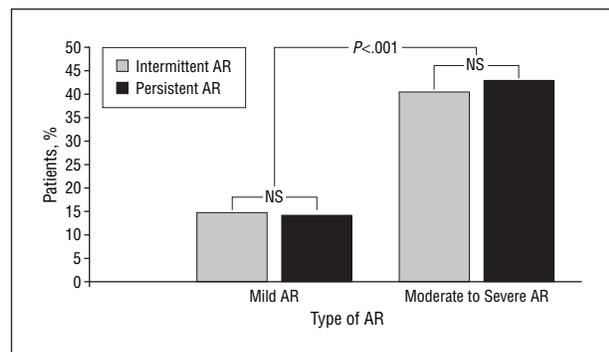
Snoring was significantly more often reported in patients with AR than in the control group ( $P < .001$ ). Based on the minimum subjective criteria (snoring loudly everyday and daytime sleepiness), sleep apnea syndrome seemed also to be more prevalent in patients with AR than in the control group (3.8% vs 0.5%;  $P < .001$ ).

## IMPACT OF AR-INDUCED POOR QUALITY OF SLEEP ON EVERYDAY LIVING

A total of 43.7% of patients with AR reported a feeling of fatigue on awakening despite a normal night's sleep. Headache at awakening, anxiety, and depression as contributing factors of sleep problems and daytime somnolence were significantly more frequently reported by patients with AR than by the control group ( $P < .001$ ).

Severity of AR had an adverse effect on memory ( $P = .01$ ) and mood ( $P = .003$ ). Compared with the control group, significantly more patients with AR reported memory impairment and decreased sexual activity ( $P < .01$ ).

The severity of AR significantly influenced the mean duration of nocturnal sleep during the week and weekends ( $P = .001$  and  $P = .002$ , respectively), the frequency of daytime sleepiness ( $P = .04$ ), the time necessary to fall asleep ( $P < .001$ ), and the necessary intake of sedative drugs ( $P = .009$ ).



**Figure 2.** Distribution of the population of patients with insomnia who also have allergic rhinitis (AR) ( $n = 19$ ) according the type of Allergic Rhinitis and its Impact on Asthma classification. NS indicates nonsignificant impact of AR frequency on insomnia.

## PREDICTIVE FACTORS FOR SLEEP DISTURBANCES IN PATIENTS WITH AR

The analyses identified several factors predictive for sleep disorders in patients with AR. Table 2 presents the factors with significant predictive value for insomnia, severe insomnia, hypersomnia, and sleep apnea.

The severity of the disease was found to be highly correlated with all types of sleep disorders whereas some concomitant medications were predictive for certain types (use of anxiolytic drugs, for example, showed strong correlation with insomnia and severe insomnia).

Male sex showed a high correlation with sleep apnea (odds ratio, 5.9; 95% confidence interval, 2.0-22.4;  $P = .003$ ), whereas asthma was correlated with severe insomnia (odds ratio, 1.75; 95% confidence interval, 1.07-2.84;  $P = .03$ ). Age, smoking habits, and residence (urban vs rural) did not have any predictive value.

## COMMENT

The present controlled epidemiological study provides important information on the relationship of AR to sleep complaints and sleep disorders. The study was conducted following strict methods and using validated tools (questionnaires) that allowed precise characterization of the study population in terms of respiratory status and sleeping status. However, questionnaires may be insufficient to assess accurately some sleep disorders (eg, sleep apnea) that require confirmation by night polygraphy or polysomnography.<sup>28</sup>

It is known that AR adversely affects quality of life,<sup>11-14</sup> but to our knowledge, prior to the study described herein, the frequency and pattern of sleep disorders in the population with AR had never been determined. Moreover, this study also addresses the consequences of sleep disorders on everyday living.

The results show a significant impact of AR on all dimensions of sleep quality and, consequently, a lower quality of life as reflected by more somnolence; daytime fatigue and sleepiness; and impaired memory, mood, and sexuality, with a significantly increased consumption of alcohol and sedatives in cases compared with the control group. Our findings are consistent with other published observations.<sup>28</sup> A limitation of this study is that

**Table 2. Predictive Factors for Sleep Disturbances in Allergic Rhinitis (AR)\***

Characteristic	Insomnia OR (95% CI)	P Value	Severe Insomnia OR (95% CI)†	P Value	Hypersomnia OR (95% CI)	P Value	Sleep Apnea OR (95% CI)	P Value
Severity of AR (moderate to severe vs mild)	4.04 (2.37-7.22)	<.001	2.67 (1.46-5.24)	.002	2.11 (1.29-3.58)	.004	NS	
Type of AR (persistent vs intermittent)	NS		NS		NS		9.58 (1.88-175.80)	.03
Treatments‡								
Anxiolytics	5.44 (2.30-14.42)	<.001	6.31 (2.69-15.76)	<.001	NS		NS	
Hypnotics	NS		NS		3.97 (1.68-10.14)	.002	NS	
Antimigraine agents	NS		NS		NS		6.14 (1.12-25.62)	.02
Asthma	NS		1.75 (1.07-2.84)	.03	NS		NS	

Abbreviations: CI, confidence interval; NS, nonsignificant; OR, odds ratio.

\*Patients with moderate to severe AR have a higher risk of insomnia, severe insomnia, and hypersomnia than those with mild AR. Patients with chronic AR have a higher risk of obstructive apnea than those with intermittent AR.

†Adjusted OR for sex and age (profile likelihood, 95% CI); profile  $> \chi^2$ .

‡Treatment with nonsteroidal anti-inflammatory drugs was a nonsignificant predictive factor.

we did not consider the potential influence of cofactors such as anxiety and depression or comorbidities such as asthma on sleep quality. The focus of this study was not on the mechanisms that link AR with altered sleep but rather to examine whether frequency and severity of AR were associated with sleep impairment. Disorders other than AR, such as comorbid disorders (eg, obstructive sleep apnea and asthma) may also have an impact on sleep quality. Therefore, comprehensive treatment of sleep disturbances in patients with AR will likely require a multimodal approach. Although the duration of AR (intermittent or persistent) had no effect on most of the evaluated parameters, the severity of the disease had a significant influence on all considered aspects.

It is important to state that possible bias in the selection and in the interview of patients may have influenced the results of the study. Patients who have AR and who have been specifically interviewed about sleep may recall their troubles more intensively than the control group interviewed in the general population. However, it seems difficult to avoid this bias in a study focused on AR, which demands a high quality of diagnosis made by ear, nose, and throat and allergy specialists. Another possible bias is that patients seen by specialists may have more medical disorders and therefore more sleep disorders than patients seen by general practitioners. But the French social security system allows patients to visit specialists as easily as general practitioners, and sleep disorders are one of the main complaints expressed by patients of general practitioners. It seems thus unlikely that patients of ear, nose, and throat specialists have more sleep problems due to other diseases than do patients of general practitioners.

General practitioners, as well as pulmonary; allergy; and ear, nose, and throat specialists, have to be made aware of the relationship between AR and sleep disorders. Our findings suggest that patients consulting for their AR should be routinely questioned about their sleep quality and existing daytime somnolence. This could lead to early detection and treatment of sleep disorders in these patients. The onus is on health care professionals to make the link between AR and sleep problems in their patients. Treating AR or other nasal symptoms may improve dramatically the quality of sleep.<sup>29</sup> In the long term, such a strategy would have positive repercussions on a societal level; for example, the numbers of road and work accidents would be reduced. Considering the high incidence of AR and the high rate of associated sleep disorders, the issue is one of public health.

**Accepted for Publication:** June 8, 2006.

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**Financial Disclosure:** Drs Chanal, El Hasnaoui, and Pribil are remunerated employees of GlaxoSmithKline Laboratory under a scientific collaboration contract.

**Funding/Support:** This study was supported by the Department of Epidemiology, GlaxoSmithKline Laboratory.

**Additional Information:** The authors have participated in the study design, results analysis, and study analysis

with no distinction between them in terms of implication in the study.

## REFERENCES

1. Van Cauwenberge P, Bachert C, Passalacqua G, et al; European Academy of Allergy and Clinical Immunology. Consensus statement on the treatment of allergic rhinitis. *Allergy*. 2000;55:116-134.
2. National Sleep Foundation. *Sleep in America: A Survey of US Adults: A Report Prepared by the Gallup Organization for the National Sleep Foundation*. Los Angeles, Calif: National Sleep Foundation; 1991.
3. Ohayon MM, Caulet M, Priest RG, Guilleminault C. *DSM-IV and ICDSD-90* insomnia symptoms and sleep dissatisfaction. *Br J Psychiatry*. 1997;171:382-388.
4. Léger D, Guilleminault C, Dreyfus JP, Delahaye C, Paillard M. Prevalence of insomnia in a survey of 12 778 adults in France. *J Sleep Res*. 2000;9:35-42.
5. Billiard M. Hypersomnias. In: Billiard M, ed. *Sleep: Physiology, Investigations and Medicine*. New York, NY: Kluwer Academic Plenum; 2003:333-336.
6. Bousquet J, Bullinger M, Fayol C, Marquis P, Valentin B, Burtin B. Assessment of quality of life in patients with perennial allergic rhinitis with the French version of the SF-36 Health Status Questionnaire. *J Allergy Clin Immunol*. 1994;94:182-188.
7. Mahler DA, Mackowiak JI. Evaluation of the Short-Form 36-Item questionnaire to measure health-related quality of life in patients with COPD. *Chest*. 1995;107:1585-1589.
8. Tripathi A, Patterson R. Impact of allergic rhinitis treatment on quality of life. *Pharmacoeconomics*. 2001;19:891-899.
9. Juniper EF, Guyatt GH. Development and testing of a new measure of health status for clinical trials in rhinoconjunctivitis. *Clin Exp Allergy*. 1991;21:77-83.
10. Stuck BA, Czajkowski J, Hagner AE, et al. Changes in daytime sleepiness, quality of life, and objective sleep patterns in seasonal allergic rhinitis: a controlled clinical trial. *J Allergy Clin Immunol*. 2004;113:663-668.
11. Scharf MB, Cohen AP. Diagnostic and treatment implications of nasal obstruction in snoring and obstructive sleep apnea. *Ann Allergy Asthma Immunol*. 1998;81:279-287.
12. McNicholas WT, Tarlo S, Cole P, et al. Obstructive apnoeas during sleep in patients with seasonal allergic rhinitis. *Am Rev Respir Dis*. 1982;126:625-628.
13. McColley SA, Carroll JL, Curtis S, Loughlin GM, Sampson HA. High prevalence of allergic sensitisation in children with habitual snoring and obstructive sleep apnoea. *Chest*. 1997;111:170-173.
14. Young T, Finn L, Kim HJ; University of Wisconsin Sleep and Respiratory Research Group. Nasal obstruction as a risk factor for sleep-disordered breathing. *J Allergy Clin Immunol*. 1997;99:S757-S762.
15. Janson C, de Backer W, Gislason T, et al. Increased prevalence of sleep disturbances and daytime sleepiness in subjects with bronchial asthma: a population study of young adults in European countries. *Eur Respir J*. 1996;9:2132-2138.
16. Bousquet J, Annesi-Maesano I, Carat F, et al; DREAMS Study Group. Characteristics of intermittent and persistent allergic rhinitis. *Clin Exp Allergy*. 2005;35:728-732.
17. Annesi-Maesano I, Didier A, Klossek JM, Chanal I, Moreau D, Bousquet J. The Score for Allergic Rhinitis (SFAR): a simple and valid assessment method in population studies. *Allergy*. 2002;57:107-114.
18. Demoly P, Allaert F, Lecasble M, Bousquet J; PRAGMA. Validation of the classification ARIA (Allergic Rhinitis and its Impact on Asthma). *Allergy*. 2003;58:672-675.
19. Bousquet J, van Cauwenberge P, Kaltaev N; ARIA Workshop group; World Health Organization. Allergic rhinitis and its impact on asthma. *J Allergy Clin Immunol*. 2001;108(5)(suppl):S147-S334.
20. Miles LEM. Sleep Questionnaire and Assessment of Wakefulness (SQAW). In: Guilleminault C, ed. *Sleeping Disorders, Indications and Techniques*. Menlo Park, Calif: Addison-Wesley; 1982:383-414.
21. Young T, Palta M, Dempsey J, Skarud J, Weber S, Badr S. The occurrence of sleep disordered breathing among middle-aged adults. *N Engl J Med*. 1993;328:1230-1235.
22. Leger D, Guilleminault C, Defrance R, Domont A, Paillard M. Blindness and sleep patterns. *Lancet*. 1996;348:830-831.
23. Diagnostic Classification Steering Committee. *International Classification of Sleep Disorders (ICSD 90: Diagnostic Coding Manual)*. Rochester, Minn: American Sleep Disorders Association; 1990.
24. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed. Washington, DC: American Psychiatric Association; 1990.
25. Johns MW. A new method for measuring daytime sleepiness: the Epworth Sleepiness Scale. *Sleep*. 1991;14:540-545.
26. Johns MW. Reliability and factor analysis of the Epworth Sleepiness Scale. *Sleep*. 1992;15:376-381.
27. Chervin RD, Aldrich MS, Pickett R, Guilleminault C. Comparison of the results of the Epworth Sleepiness Scale and the Multiple Sleep Latency Test. *J Psychosom Res*. 1997;42:145-155.
28. Kremer B, den Hartog HM, Jolles J. Relationship between allergic rhinitis, disturbed cognitive functions, and psychological well-being. *Clin Exp Allergy*. 2002;32:1310-1315.
29. Hughes K, Glass C, Ripchinski M, et al. Efficacy of the topical nasal steroid budesonide on improving sleep and daytime somnolence in patients with perennial allergic rhinitis. *Allergy*. 2003;58:380-385.