

Changes in daytime sleepiness, quality of life, and objective sleep patterns in seasonal allergic rhinitis: A controlled clinical trial

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Background: It has long been assumed that allergic rhinitis leads to daytime sleepiness and a deterioration of nocturnal sleep, yet systematic studies have only been rarely conducted in this field.

Objective: The aim of the present study was to investigate the effects of seasonal allergic rhinitis on subjective and objective sleep patterns, quality of life, and daytime sleepiness in otherwise healthy subjects in comparison with nonallergic volunteers.

Methods: Twenty-five patients with seasonal allergic rhinitis and 25 healthy volunteers were enrolled in this prospective, controlled clinical trial. Daytime sleepiness and quality of life were assessed with the help of questionnaires (Epworth Sleepiness Scale, SF-36); 2 consecutive nights of fully attended polysomnography were performed before and during the pollen season of 2002.

Results: Statistically significant differences between groups were found in respect to changes in daytime sleepiness and selected parameters of quality of life. Impairment of daytime sleepiness and quality of life were related to the severity of the disease. Statistically significant differences were also found for selected parameters of the sleep studies, although the changes were only minimal, and all values were within normal ranges. **Conclusion:** Seasonal allergic rhinitis leads to increased daytime sleepiness, as well as to an impairment of quality of life, depending on the severity of the disease. Objective measurements revealed a statistically significant influence of seasonal allergic rhinitis on selected sleep parameters, but changes were not of clinical relevance. Daytime sleepiness seems to be related to the condition itself rather than to an impairment of nocturnal sleep. (*J Allergy Clin Immunol* 2004;113:663-8.)

Key words: Seasonal allergic rhinitis, daytime sleepiness, quality of life, polysomnography

Apart from the classical symptoms, allergic patients often complain about a general impairment of their daytime performance and psychologic well-being.¹ Quality of life seems to be significantly affected by this condition.²⁻⁴ Furthermore, allergic rhinitis goes along with daytime

Abbreviations used

AHI: Apnea-hypopnea index
AI: Apnea index
ESS: Epworth Sleepiness Scale
HI: Hypopnea index
REM: Rapid eye movement

sleepiness.⁵ The increased daytime sleepiness has been attributed to nocturnal sleep loss or to an impairment of sleep in general.⁶⁻⁸

On the other hand, allergic rhinitis is a risk factor for sleep-disordered breathing in children.^{9,10} However, the significance of nasal obstruction caused by allergic rhinitis in patients with obstructive sleep apnea has been controversial.^{11,12}

It has long been assumed that allergic rhinitis leads to a deterioration of nocturnal sleep, yet studies investigating these effects have only rarely been conducted and often had methodological limitations.¹³⁻¹⁵

Therefore the aim of the present study was to investigate the effects of seasonal allergic rhinitis on subjective and objective sleep patterns, quality of life, and daytime sleepiness in otherwise healthy subjects in comparison with a matched group of nonallergic volunteers in a prospective, controlled clinical trial.

METHODS

The study was conducted at the Department of Otorhinolaryngology, Head and Neck Surgery Mannheim before and during the pollen season of 2002. Twenty-five patients with seasonal allergic rhinitis and 25 healthy volunteers matched for age, sex, and body mass index were included.

The study protocol was approved by the local ethical board of the Faculty of Clinical Medicine Mannheim of the University of Heidelberg, and written informed consent was obtained from all participating subjects.

Inclusion criteria

Female and male subjects between the age of 18 and 65 years with the presence (patients) or absence (control group) of seasonal allergic rhinitis against grass pollen, tree pollen, or both were included. Seasonal allergic rhinitis was diagnosed or ruled out on the basis of medical history, clinical assessment, and skin prick tests with commercially available allergens (Allergopharma Joachim Ganzer KG). The following seasonal allergens were used for the skin test: birch, hazel, alder, ash, willow, oak, beech, elder, grass, rye, oat,

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wheat, and herbs. In the subjects with allergic rhinitis, the condition had to be present and stable for at least 3 years for the subject to be included in the study.

Exclusion criteria

Perennial allergic rhinitis was ruled out in both groups with the help of medical history, clinical assessment, and skin prick tests, as mentioned above. Subjects with a history of sleep disorders, sleep-disordered breathing, severe snoring, or any other illness affecting sleep, quality of life, or daytime performance were also excluded. Finally, patients with chronic cough, asthma, or atopic dermatitis were excluded. A general otorhinolaryngologic examination, including nasal endoscopy, was performed to exclude subjects with relevant septal deviation, nasal polyps, acute or chronic rhinosinusitis, or any other underlying pathology that might affect nasal breathing or nocturnal sleep. The subjects were not allowed to use any antiallergic medication during the course of the study, as well as other drugs that might affect sleep or daytime performance.

Study methods

All subjects underwent 2 consecutive nights of fully attended polysomnography before, as well as during, the pollen season of 2002. The extraseasonal measurements were obtained at least 2 months before the individual pollen season. For the intraseasonal assessment, subjects were scheduled in accord with the expected time of maximum symptoms for the individual subject.

At that time, the actual presence of 5 allergy symptoms (nasal itching, nasal obstruction, sneezing, itching of the palate, and watery eyes) was quantified on a 10-digit scale (0, no problem; 10, severe problem) by the subjects. According to the overall symptom score, patients were classified as having either mild (score, 0-15), moderate (score, 16-30), or severe (score, >30) rhinitis. Furthermore, quality of life and daytime sleepiness were assessed with well-established questionnaires: the SF-36 and the Epworth Sleepiness Scale (ESS).

The ESS is a standardized questionnaire for the self-assessment of daytime sleepiness frequently used in the field of sleep research.¹⁶ The likelihood of falling asleep during defined situations (eg, watching television or driving in a car as a codriver) is quantified by the subject, and a score is then calculated to assess daytime sleepiness. The normative value for healthy subjects is 5.9 ± 2.2 .

The polysomnography testing itself was performed according to the principles of the American Academy of Sleep Medicine.¹⁷ Monitoring included 2 electro-oculograms, 2 submental and 2 leg electromyograms, electrocardiograms, oronasal airflow, thoracic and abdominal efforts, pretracheal microphone, pulse oximetry, body position, and 4 electroencephalograms (C3, C4, O1, and O2). All the polysomnographies were evaluated at the end of the study under standardized blinded conditions by 2 sleep technicians. Results of the sleep studies are given as mean values of the 2 consecutive nights.

The following objective measurements were considered as relevant for the present study: apnea index (AI; number of apneas per hour), hypopnea index (HI; number of hypopneas per hour), apnea-hypopnea index (AHI), arousal index (number of arousals per hour), mean oxygen saturation, minimal oxygen saturation, snoring time in minutes, movement time in minutes, and percentage of time at sleep stages I, II, slow wave sleep, and rapid eye movement (REM), all in relation to total sleep time. Finally, sleep latency (time from turning off the lights to first episode of sleep stage 3 or to 3 consecutive episodes of sleep stage 1 in minutes) and sleep efficacy in percentage (total sleep time divided by time in bed) were measured.

Sleep stages were scored according to the method of Rechtschaffen and Kales.¹⁸ In this classification sleep is divided into REM and non-REM sleep, and the latter is then subdivided into sleep stages 1 and 2 (light sleep) and slow wave sleep (stages 3 and 4 [deep sleep]) on the basis of characteristic findings on electroencephalography.

Hypopnea was defined as a decrease of more than 50% in the amplitude of breathing lasting 10 seconds or longer. Apnea was defined as a complete cessation of breathing lasting 10 seconds or longer.

Statistics

The statistical analysis was conducted at the Department of Statistics of the Faculty of Clinical Medicine Mannheim. Results were normalized to baseline by subtracting those before from those during the pollen season, and the changes between the 2 groups were compared. A 2-sample rank sum test for nonpaired comparisons was used with the SAS program to assess differences between groups. A *P* value of less than .05 is considered statistically significant in this study. For regression analysis, the Pearson correlation coefficient was used with the SAS program.

RESULTS

Forty-nine of 50 subjects completed the study. One patient with seasonal allergic rhinitis was excluded because she refused to complete the intraseasonal sleep study.

In the group of subjects with allergic rhinitis (12 female and 12 male subjects), the mean age was 27.0 ± 4.9 years. Mean body mass index was 23.0 ± 3.5 kg/m². Seven patients were only allergic to grass pollen, and 17 were allergic to both grass and tree pollen. In the control group of healthy volunteers (13 female and 12 male subjects), the mean age was 26.4 ± 5.5 years. Mean body mass index was 22.4 ± 2.1 kg/m². There were no statistically significant differences in age or body mass index between the 2 groups (*P* > .05).

For all 49 subjects, 2 sleep studies could be completed before, as well as during, the pollen season. In total, 196 fully attended polysomnographies were performed.

Symptom scores

The overall symptom score for the allergic patients during the season was 21.3 ± 13.1 compared with 1.08 ± 2.7 at baseline. Nine patients had mild rhinitis (mean score, 7.8 ± 4.7), 7 patients had moderate disease (mean score, 21.4 ± 5.0), and 8 patients were classified as having severe allergic rhinitis (mean score, 36.4 ± 5.1). The nonallergic control subjects had no allergic symptoms at extraseasonal and intraseasonal presentation (mean score, 0). This leads to statistically significant differences between the 2 groups for every symptom, as well as for the overall symptom score (*P* < .001). The individual overall symptom score for every subject is shown in Table I.

Daytime sleepiness

Daytime sleepiness before the pollen season was within the physiologic limits in both study groups. The mean scores for the ESS before the season were 6.8 ± 2.7 for the allergic patients and 5.4 ± 2.4 for the healthy control subjects. Daytime sleepiness was increased at the intraseasonal assessment in the allergy group (8.2 ± 3.4) but remained unchanged in the control group (5.3 ± 2.4). There was a statistically significant difference between the

TABLE I. Overall symptom scores before and during the season for the individual subjects

Subject no.	Allergic subjects		Healthy control subjects	
	Extra-seasonal	Intra-seasonal	Extra-seasonal	Intra-seasonal
1	0	3	0	0
2	0	34	0	0
3	0	25	0	0
4	0	47	0	0
5	0	36	0	0
6	4	26	0	0
7	6	31	0	0
8	0	10	0	0
9	0	16	0	0
10	0	3	0	0
11	0	9	0	0
12	0	39	0	0
13	5	37	0	0
14	0	2	0	0
15	0	36	0	0
16	0	10	0	0
17	0	31	0	0
18	0	16	0	0
19	0	5	0	0
20	11	21	0	0
21	0	28	0	0
22	0	18	0	0
23	0	15	0	0
24	0	13	0	0
25			0	0

2 groups concerning the changes in daytime sleepiness according to the adjusted values ($P = .048$), which indicates that allergic rhinitis leads to an increase in daytime sleepiness. Yet this difference was solely due to the subgroup of patients with moderate to severe disease only (Fig 1).

Quality of life

Quality of life measured with the SF-36 reached comparable levels in both groups at the extraseasonal assessments. Compared with this baseline, all parameters, apart from mental health, deteriorated in the allergic group. In the control group several parameters remained unchanged (physical function and general health); several deteriorated, although only to a relatively small extent (role physical, bodily pain, vitality, social function, and mental health); and one (role emotional) improved. Comparing the changes before and during the pollen season between the 2 groups, statistically significant differences could be found for the quality-of-life parameters physical function ($P < .0001$) and role physical ($P < .0001$). Interestingly, there was also a statistically significant difference for mental health ($P = .046$), but this showed a reverse relationship. The detailed results are shown in Table II.

The changes in quality of life are again more pronounced in the subgroups of patients with moderate-to-severe allergic rhinitis. The detailed results of the stratified analysis are shown in Table III.

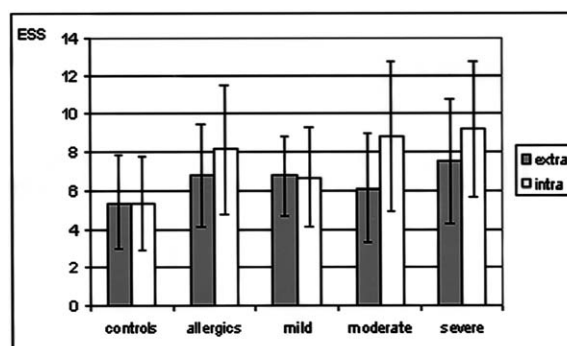


FIG 1. Daytime sleepiness for the different study groups. ESS scores for the groups of control subjects ($n = 25$) and allergic patients ($n = 24$), as well as for the subgroups of patients with mild ($n = 9$), moderate ($n = 7$), and severe ($n = 8$) allergic rhinitis are shown (mean values $\pm$ SD). Extra, Extraseasonal; intra, intra-seasonal.

Objective assessment of sleep

In general, the changes seen during the course of the study were mostly minimal and not always conclusive, although some changes lead to statistically significant differences between the 2 groups.

Concerning the respiratory parameters, a slight increase of the indices was detected for the allergy group (AI, 0.07 ± 0.08 to 0.28 ± 0.28 ; HI, 0.25 ± 0.27 to 0.55 ± 0.57 ; AHI, 0.32 ± 0.29 to 0.81 ± 0.71), whereas these parameters were all unchanged in the control group (AI, 0.05 ± 0.09 to 0.04 ± 0.07 ; HI, 0.18 ± 0.15 to 0.12 ± 0.12 ; AHI, 0.21 ± 0.17 to 0.17 ± 0.14), leading to statistically significant differences for AI ($P < .001$), HI ($P < .005$), and AHI ($P < .001$).

There were no statistically significant differences between the 2 groups in regard to changes in oxygen saturation. Concerning the mean nocturnal oxygen saturation, no relevant changes were seen, either in the subjects with allergic rhinitis (extraseasonal: 96.0 ± 1.1 ; intra-seasonal: 95.9 ± 1.13) or in the healthy control subjects (extraseasonal: 96.5 ± 0.77 ; intra-seasonal: 96.4 ± 0.94). Similar results were obtained for minimal nocturnal oxygen saturation (allergic subjects: extra-seasonal: 92.3 ± 2.22 ; intra-seasonal: 91.6 ± 2.91 ; healthy control subjects: extra-seasonal: 93.3 ± 2.65 ; intra-seasonal: 93.5 ± 2.05).

Snoring time was higher during the pollen season in the subjects with allergic rhinitis, with a mean intra-seasonal snoring time of 4.24 ± 12.0 minutes compared with 0.27 ± 0.98 minutes at baseline. Snoring time also increased in the control group, although to a lesser extent, from 0.01 ± 0.04 minutes at baseline to 0.16 ± 0.26 minutes during the season, resulting in a statistically significant difference between the groups ($P = .006$).

The changes in sleep stages for the allergic patients were inconsistent. Only minimal or no changes could be detected in the control group. Concerning the differences between groups for changes in sleep parameters, only for REM sleep were statistically significant differences seen (REM, $P = .008$); this was caused by an increase of REM sleep in patients with allergic rhinitis because of the pollen

TABLE II. Aspects of quality of life measured with the SF-36

SF-36	Allergy group				Control group			
	Before season		During season		Before season		During season	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Physical function*	97.4	8.89	87.9	13.0	98.4	3.74	98.8	3.32
Role physical*	97.9	7.06	74.3	24.5	100	0	94.0	20.8
Bodily pain	96.2	11.1	90.9	16.5	97.0	10.5	95.3	11.7
General health	83.8	13.4	78.8	17.5	83.2	12.6	84.8	11.9
Vitality	63.2	17.6	56.0	14.2	66.8	11.1	62.4	13.6
Social function	93.1	14.0	82.8	19.4	94.0	11.3	91.0	13.3
Role emotional	94.4	16.2	93.1	21.9	86.6	30.5	93.3	21.6
Mental health*	79.3	12.5	80.4	11.3	80.5	8.51	74.3	12.7

Data are presented as means $\pm$ SDs.* $P < .05$.**TABLE III.** Aspects of quality of life measured with the SF-36 for allergic patients with different degrees of allergic rhinitis

SF-36	Mild disease				Moderate disease				Severe disease			
	Before season		During season		Before season		During season		Before season		During season	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Physical function	99.4	1.67	93.9	4.17	99.3	1.89	87.9	10.4	93.3	15.0	81.3	18.7
Role physical	100.0	0.00	81.9	24.3	96.4	9.45	67.1	25.3	96.9	8.84	71.9	24.8
Bodily pain	94.0	13.3	98.2	5.33	100.0	0.00	85.4	18.6	95.3	13.4	87.4	21.2
General health	88.1	12.6	88.0	13.6	79.1	11.5	78.1	11.4	83.1	15.9	69.0	21.4
Vitality	63.3	15.2	62.8	16.6	61.4	13.8	55.7	8.86	64.6	24.2	48.8	12.8
Social function	88.6	19.7	83.3	22.5	100.0	0.00	80.4	15.9	92.2	11.5	84.4	20.9
Role emotional	92.6	22.3	96.3	11.1	100.0	0.00	95.2	12.6	91.6	15.6	87.5	35.4
Mental health	80.4	12.4	87.8	5.52	82.3	6.47	80.0	5.66	75.5	16.6	72.5	14.6

Data are presented as means $\pm$ SDs.

season (extraseasonal, $10.4\% \pm 5.93\%$; intraseasonal, $14.1\% \pm 4.29\%$). Statistically significant differences for light or slow wave sleep could not be detected.

No statistically significant differences were seen between the groups for movement time or arousal index. Sleep latency was shorter in both groups during the pollen season (reduction from 98.0 ± 37.6 to 71.2 ± 30.0 minutes for allergic subjects and from 93.3 ± 39.9 to 79.9 ± 33.3 minutes for healthy control subjects). Statistically significant differences between the 2 groups could not be detected.

Finally, sleep efficacy was reduced in the allergy group from $94.2\% \pm 5.77\%$ to $92.1\% \pm 7.62\%$ but increased in the control group from $94.3\% \pm 3.53\%$ to $97.1\% \pm 2.54\%$, leading to statistically significant differences ($P = .02$). Nevertheless, even the intraseasonal sleep efficacy of 92% for the allergy group remained in normal limits.

The results for the polysomnographic data are shown in Table IV.

The more pronounced effects on subjective results could not be confirmed by the majority of the objective data. Even for patients with moderate-to-severe disease, results from the sleep studies were within normal limits. Only the increase in snoring time was mainly seen in the patients with severe allergic rhinitis. The extraseasonal and intraseasonal results of the sleep studies for the 3 different subgroups of allergic patients are shown in Table V.

Regression analysis

There was a very weak correlation between the changes in nasal symptom scores and snoring ($r = 0.128$) and objective sleep patterns, namely the AHI ($r = 0.124$). No correlation was found for changes in daytime sleepiness and snoring ($r = 0.021$) and AHI ($r = 0.076$).

DISCUSSION

The present study investigated the effects of seasonal allergic rhinitis on daytime sleepiness, quality of life, and objective sleeping patterns in a prospective, controlled clinical trial.

The pollen season was found to induce an increase of daytime sleepiness in patients with seasonal allergic rhinitis, while not affecting the daytime sleepiness of healthy volunteers, which led to statistically significant differences between the 2 groups. The increase in daytime sleepiness was more pronounced in patients with moderate-to-severe allergic rhinitis.

Daytime fatigue caused by seasonal allergic rhinitis was described earlier^{5,7} but has never been evaluated systematically. Craig et al¹³ investigated the effects of topical nasal steroids on daytime sleepiness but were not able to demonstrate a statistically significant improvement. Standardized questionnaires for the evaluation of daytime sleepiness, such as the ESS, have not previously been used in this context.

TABLE IV. Relevant parameters of the sleep studies for both groups

	Allergy group				Control group			
	Before season		During season		Before season		During season	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
AI*	0.07	0.08	0.28	0.28	0.05	0.09	0.04	0.07
HI*	0.25	0.27	0.55	0.57	0.18	0.15	0.12	0.12
AHI*	0.32	0.29	0.81	0.71	0.21	0.17	0.17	0.14
O ₂ Mean	96.0	1.07	95.9	1.13	96.5	0.77	96.4	0.94
O ₂ Minimal	92.3	2.22	91.6	2.91	93.3	2.65	93.5	2.05
Snoring time*	0.27	0.98	4.24	12.0	0.01	0.04	0.16	0.26
Stage 1	13.8	7.58	15.1	11.2	12.8	9.42	14.9	9.71
Stage 2	53.4	8.74	51.9	9.36	54.9	7.75	55.2	7.20
SWS	21.0	6.03	17.5	5.58	19.1	5.62	18.2	5.59
REM*	10.4	5.93	14.1	4.29	11.4	5.68	10.2	4.75
Movement time	1.43	0.64	1.68	0.79	1.94	0.96	1.56	0.67
Arousals	16.8	7.11	16.2	4.40	16.0	6.72	19.1	10.4
Sleep latency	98.0	37.6	71.2	30.0	93.3	39.9	79.9	33.3
Sleep efficacy*	94.2	5.77	92.1	7.62	94.3	3.53	97.1	2.54

Data are presented as means $\pm$ SDs.

* $P < .05$.

TABLE V. Parameters of polysomnographic studies for allergic patients with different degrees of allergic rhinitis

	Mild disease				Moderate disease				Severe disease			
	Before season		During season		Before season		During season		Before season		During season	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
AI	0.03	0.06	0.27	0.19	0.07	0.08	0.31	0.43	0.10	0.10	0.26	0.23
HI	0.36	0.38	0.58	0.68	0.25	0.19	0.59	0.68	0.13	0.13	0.49	0.33
AHI	0.40	0.42	0.84	0.66	0.31	0.21	0.90	1.05	0.24	0.18	0.69	0.44
O ₂ Mean	95.8	1.22	95.9	1.10	96.6	0.93	96.5	1.04	95.63	0.88	95.2	1.00
O ₂ Minimal	92.6	2.23	92.4	2.50	93.8	0.84	91.7	3.19	90.91	2.24	90.6	3.22
Snoring time	0.03	0.08	0.91	2.03	0.66	1.74	0.74	1.27	0.20	0.55	11.1	19.7
Stage 1	15.5	10.2	11.8	6.53	15.1	6.46	19.9	16.8	10.56	4.22	14.7	8.99
Stage 2	50.4	9.87	54.3	10.1	57.1	8.76	50.3	12.5	53.54	6.94	50.6	5.09
SWS	20.8	5.75	17.6	7.23	18.3	2.71	15.4	4.88	23.6	7.75	19.1	3.88
REM	12.1	7.29	14.6	3.73	8.08	4.66	13.0	3.83	10.56	5.22	14.5	5.52
Movement time	1.22	0.58	1.66	0.84	1.34	0.59	1.53	0.93	1.74	0.70	1.83	0.67
Arousals	20.1	9.69	15.7	3.88	16.5	3.84	18.9	5.02	13.31	4.28	14.6	3.82
Sleep latency	93.8	35.2	84.8	34.1	98.6	49.0	72.9	23.2	102.1	33.51	54.3	24.4
Sleep efficacy	94.7	4.06	93.5	4.93	93.4	8.04	91.3	10.6	94.16	5.85	91.1	7.91

Data are presented as means $\pm$ SDs.

Quality of life measured with the SF-36 was affected in patients with allergic rhinitis, whereas it remained unchanged in the control group, with the exception of the mental health parameter, which was reduced during the pollen season. These changes again were responsible for statistically significant differences between the 2 groups for physical function and role physical, as well as, in a reverse manner, for mental health. The impairment of quality of life was again more pronounced in those patients with moderate-to-severe disease.

A reduction in quality of life caused by allergic rhinitis has been described before.²⁻⁴ In the majority of studies addressing quality of life in patients with allergic rhinitis, the Rhinitis Quality of Life Questionnaire was used. In the present study we decided to use the SF-36 questionnaire because the Rhinitis Quality of Life Questionnaire is designed especially for patients with allergic rhinitis and cannot be used for healthy control subjects.

In a study by Leynaert et al² using the SF-36, reduced values for most of the aspects of this questionnaire were demonstrated in a population-based study of patients with allergic rhinitis. Majani et al³ also could demonstrate a significant impairment of quality of life, namely for physical function, role physical, vitality, social function, and role emotional when comparing symptomatic patients with seasonal allergic rhinitis with a reference sample.

Controlled clinical trials comparing quality of life outside and during the pollen season between patients and healthy control subjects have not been performed to date.

Objective assessment of nocturnal sleep by means of polysomnography revealed significant differences between the 2 groups for selected parameters, such as respiratory events, snoring time, and REM sleep. Nevertheless, these changes or differences were not of clinical relevance, and all the parameters assessed were within normal limits during the course of the study. Even

in patients with severe allergic rhinitis, no clinically relevant deterioration in objective sleep patterns could be detected. Sleep latency was shorter in both groups during the pollen season, which might be because of the fact that over time the subjects were becoming more familiar with the polysomnography setting.

In a prospective study McNicholas et al¹⁵ compared results of sleep studies during and outside the symptomatic phase in 7 patients with seasonal allergic rhinitis. They could demonstrate an increased number of respiratory events during the symptomatic phase, which was comparable with our results in regard to the occurrence frequency. Although the mean number of obstructive events per hour was only 1.7 ± 0.3 , they concluded that allergic rhinitis might be a risk factor for obstructive sleep apnea. A control group was not investigated in this study.

Krouse et al¹⁹ compared the results of sleep studies between a group of 4 subjects with allergic rhinitis and 4 healthy control subjects and found differences in sleep and REM latency. Finally, Lavie et al¹⁴ compared the results of sleep studies between a group of 14 symptomatic patients with allergic rhinitis and a group of 7 healthy volunteers. They found that there was a higher incidence of sleep-disordered breathing associated with microarousals in the group of allergic patients. Measurements outside the pollen season had not been performed.

In discussing the results of the present study with regard to the abovementioned literature, it has to be said that to date there are no other studies comparing intraseasonal and extraseasonal results of sleep studies between allergic patients and healthy volunteers. Nevertheless, the increase of obstructive events seen in our patients is comparable with that seen in the study of McNicholas et al.¹⁵ Our results support the notion of allergic rhinitis being a risk factor for snoring or for sleep-disordered breathing in general, but we have to stress that although the differences seen were statistically significant, they were only of minor extent and not clinically relevant. One reason for this could be that all the participating subjects in the present study were relatively young, otherwise healthy, and had no history of sleep disorders.

Therefore daytime sleepiness seems to be related to the condition itself rather than to an impairment of nocturnal sleep. This interpretation is supported by the lack of a correlation between daytime sleepiness and objective sleep patterns (eg, snoring time or AHI).

Nevertheless, the effects of allergic rhinitis might be more pronounced in older patients, in patients with other allergy-related comorbidities (eg, bronchial asthma), or in patients with preexisting sleep-disordered breathing.

The results of this prospective, controlled clinical trial demonstrate that seasonal allergic rhinitis leads to an increased daytime sleepiness, as well as to an impairment of quality of life. Both effects are related to the severity of the disease and are more pronounced in those patients with moderate-to-severe allergic rhinitis.

Objective measurements revealed a statistically significant influence of seasonal allergic rhinitis on sleeping

patterns for selected parameters. Nevertheless, these changes were not of clinical relevance, and even the intraseasonal results of patients with moderate-to-severe allergic rhinitis were within normal limits.

The differences in daytime sleepiness could not be explained with the changes in objective sleeping patterns. This is the first study to demonstrate that daytime sleepiness in allergic rhinitis seems to be related to the condition itself rather than to an impairment of nocturnal sleep.

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