

Assessing outcomes from the sleep disturbance associated with rhinitis

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Purpose of review

The purpose of this review is to identify which aspects of allergic rhinitis limit the quality of life in patients, to present information on how rhinitis affects sleep, and to review instruments available to assess the impact that rhinitis has on sleep.

Recent findings

Subjective and objective instruments reveal patients with allergic rhinitis frequently suffer from sleep-disordered breathing, poor sleep quality, daytime somnolence, and fatigue. Sleep disturbances associated with allergic rhinitis can lead to decreased cognitive and psychomotor abilities, impaired work performance, decreased productivity, impaired learning, difficulty concentrating, and memory deficits.

Summary

Objective and subjective instruments are available to measure the extent of compromise in quality of life in affected patients. Subjective measurements available to evaluate allergic rhinitis include general and disease specific quality of life questionnaires, including rhinitis specific and sleep specific questionnaires. Objective measurements available include evaluation of nasal patency and physiology in rhinitis, nasal inspiratory peak flow, acoustic rhinometry, rhinomanometry, polysomnography, the Multiple Sleep Latency Test, the Maintenance of Wakefulness Test, and learning and performance testing. The continued utilization of these and other available instruments is vital for further assessment on the effect of allergic rhinitis on sleep.

Keywords

allergic rhinitis, objective measurement, quality of life, sleep, subjective measurement

Abbreviations

AHI	apnea-hypopnea index
CSAQLI	Calgary Sleep Apnea Quality of Life Index
ESS	Epworth Sleepiness Scale
MiniRQLQ	Mini Rhinoconjunctivitis Quality of Life Questionnaire
MSLT	Multiple Sleep Latency Test
RQLQ	Quality of Life Rhinitis Specific Questionnaire
MWT	Maintenance of Wakefulness Test
SF-36	Short Form 36

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Introduction

It is estimated that 20–40 million Americans, up to 40% of children and 10–30% of adults, suffer from allergic rhinitis [1] and the prevalence appears to be on the rise [2]. Patients suffering from allergic rhinitis often report impairment in daily performance and a decreased quality of life [3^{••},4[•],5,6]. Nasal congestion is consistently rated as the most bothersome and severe symptom associated with allergic rhinitis [7,8]. Nasal congestion is thought to lead to sleep disordered breathing and poor sleep quality, with resultant daytime somnolence, fatigue, and impairment [2,8–12].

Sixty-eight percent of individuals with perennial allergic rhinitis and 48% of individuals with seasonal allergic rhinitis report interference with sleep while symptomatic and this is most often due to congestion and rhinorrhea [8,13]. Individuals with nocturnal allergic rhinitis are more likely to snore and have daytime somnolence than nonallergic individuals. Allergic adults exhibit decreased cognitive and psychomotor abilities leading to impaired work performance and decreased productivity [14], while children with allergic rhinitis are more likely to experience impaired learning with increased difficulty concentrating and memory deficits during school, leading to poorer school performance and absenteeism when compared to unaffected classmates [15,16].

Allergic rhinitis and sleep disturbance

Only 17% of patients with allergic rhinitis rate their sleep as optimal. Fifty percent of respondents report nasal congestion causes waking from sleep at night as well as making it difficult to fall asleep at night. Other significant sleep related problems include the inability to fall asleep, reported in 26% of adults and 21% of children [8].

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Mechanism of sleep disturbance

The ability to pass air adequately through the nose is essential for normal sleep [8]. Congestion from allergic rhinitis causes obstruction of the nasal passages, which leads to increased airflow resistance. The horizontal position obtained during sleep leads to further increases in nasal airway resistance. Increased effort is required to breathe against the resistance resulting in turbulence in airflow, retropharyngeal collapse, and snoring. Microarousals ensue and lead to fragmented sleep and decreased rapid eye movement (REM) during sleep. It appears that microarousals are 10 times more common in individuals with allergic rhinitis and nasal congestion than individuals without allergic disease. Multiple other investigators have also documented poor sleep on polysomnography in patients with rhinitis [17].

Subjective instruments

The majority of studies addressing the effect of allergic rhinitis on sleep utilize subjective measurements through questionnaires to assess daily symptom scores, sleep problems, daytime somnolence, fatigue, and quality of life. Both generalized health related questionnaires and disease specific quality of life questionnaires are available. A number of subjective instruments are summarized in Table 1. Subjective questionnaires are inexpensive, easy to use and administer, and most are standardized to demonstrate reliability, validity, and reproducibility. Generalized health related questionnaires and disease specific questionnaires are often used in combination to determine the impact of disease on quality of life [18–21,22•].

The most commonly utilized questionnaire to assess rhinitis is the Rhinitis Severity Score. This instrument only assesses rhinitis symptoms including congestion, rhinorrhea, sneezing, pruritis, and eye symptoms, and does not assess the results of these symptoms. Assessment of patients with questionnaires not limited to rhinitis symptoms reveals approximately 90% of patients report impairment in their daily activities, sleep, school performance, and work performance [2,4•]. Impairment is most often related to mood, sleep disturbances, impairment in activities, and social functioning [2,4•]. Respondents with more severe and persistent rhinitis symptoms score significantly worse than those with less severe or intermittent symptoms on quality of life instruments [4•].

Health-related quality of life scores comparing patients with allergic rhinitis and healthy controls reveal a significant difference in quality of life parameters. Patients with allergic rhinitis report a significant decrease in physical functioning, loss of energy, fatigue, decreased social functioning, physical limitations, decreased mental health, and increased perception of pain [23]. Many quality of life surveys exist, are valid, and provide

quantitative data. Short Form 36 (SF-36) is a general assessment tool and can be applied to any disease. Juniper's Quality of Life Rhinitis Specific Questionnaire (RQLQ) and the Nocturnal Rhinoconjunctivitis Quality of Life Specific Questionnaire (NRQLQ) focus on rhinitis.

Generalized health related questionnaires

The short-form health survey (SF-36) was designed as a self-administered or trained interviewer questionnaire for use in clinical practice, clinical research, health policy evaluations, and general population surveys for measuring generic health perception in the general population. The SF-36 assesses eight domains of health including limitations in physical activity due to health problems, limitations in social activities due to physical or emotional problems, limitations in usual role activities due to physical health problems, bodily pain, psychological distress and well being, energy and fatigue, limitations in usual role activities due to emotional problems, and self evaluation of general health. The form is simple to use, internally consistent, and useful as a valid measure of the health status in the general population [24–26]. Other questionnaires such as the Nottingham Health Profile (NHP) measure similar outcomes [26,27].

Rhinitis specific questionnaires

Questionnaires specific to rhinitis include the RQLQ, the Mini Rhinoconjunctivitis Quality of Life Questionnaire (MiniRQLQ), the NRQLQ, and the Rhinitis Quality of Life Questionnaire [28–32]. Rhinoconjunctivitis specific questionnaires emphasize the problems and symptoms patients commonly complain of related to rhinitis and sleep and are more sensitive to alterations in patients' quality of life than generic health-status questionnaires [13,33].

The RQLQ is a disease specific health-related quality of life instrument for symptomatic adults with atopic and nonatopic rhinoconjunctivitis that measures both physical and emotional aspects of the disease. The questionnaire has both self-administered and interviewer-administered formats. Twenty-eight questions are asked on a seven-point scale to assess limitations in activity, problems related to sleep, nasal symptoms, eye symptoms, non-nose and eye symptoms, emotional function, and practical problems associated with rhinoconjunctivitis. This questionnaire has been used in numerous large studies throughout the world [28,29].

The MiniRQLQ was developed as a shorter version of the RQLQ. This self-administered questionnaire has 14 questions asked on a seven-point scale to assess limitations in activity, nasal symptoms, eye symptoms, non-nose and eye symptoms, and practical problems associated with rhinoconjunctivitis [30]. The Rhinitis

Table 1 Subjective health-related quality of life instruments

Instrument	Domains measured	Effect from rhinitis	Effect with treatment	Citations
Generic				
Psychological testing	Well being	Decreased psychological well being		[9]
Short-Form Health Survey (SF-36)	Limitations in physical activity Limitations in social activity Limitations in usual role activity Due to physical problems Due to emotional problems Bodily pain Psychological distress Energy and fatigue Self evaluation of health status Energy Sleep Emotional reactions Pain Physical mobility Social isolation	Decreased quality of life	Improvement in quality of life scores following treatment with nonsedating antihistamines and intranasal corticosteroids	[6,22 ^{••} ,24–26,52]
Nottingham Health Profile (NHP)		Decreased quality of life		[22 ^{••} ,26,27]
Rhinitis specific				
Juniper's Rhinoconjunctivitis Quality of Life Questionnaire (RQLQ)	Limitations in activity Problems related to sleep Nasal symptoms Eye symptoms Non-nose and eye symptoms Emotional function Practical problems associated with rhinoconjunctivitis Limitations in activity Nasal symptoms Eye symptoms Non-nose and eye symptoms Practical problems associated with rhinoconjunctivitis Problems with sleep	Decreased quality of life	Improvement in quality of life scores following treatment with antihistamines, leukotriene receptor antagonists, and intranasal corticosteroids	[4 [•] ,6,28,29,50,69]
Mini Rhinoconjunctivitis Quality of Life Questionnaire (MiniRQLQ)		Decreased quality of life	Improvement in quality of life scores following treatment with antihistamines, leukotriene receptor antagonists, and intranasal corticosteroids	[30]
The Nocturnal Rhinoconjunctivitis Quality of Life Questionnaire (NRQLQ)	Symptoms during sleep time Symptoms on waking in the morning Practical problems	Decreased quality of life	Improvement in quality of life scores following treatment with intranasal corticosteroids	[32]

Table 1 (continued)

Instrument	Domains measured	Effect from rhinitis	Effect with treatment	Citations
Sleep Specific The Epworth Sleepiness Scale (ESS)	Likelihood of falling asleep during eight daytime situations	Greater daytime somnolence	Symptom scores improve with use of intranasal corticosteroids	[3••,33,34,52,53,67]
The Pittsburgh Sleep Quality Index (PSQI)	Sleep quality Sleep latency Sleep duration Habitual sleep efficiency Sleep disturbances Use of sleep medications Daytime dysfunction Activity level	Worsens symptoms		[35]
The University of Pennsylvania Functional Outcomes of Sleep (FOSQ)	Vigilance Intimacy and sexual relationships General productivity Social outcome	Worsens symptoms	Symptom scores improve with use of intranasal corticosteroids	[37]
Sleep apnea specific The Calgary Sleep Apnea Quality of Life Index (CSAQLI)	Normal daily routine Social interactions Emotional functioning Symptoms Treatment-related symptoms			[36]

Quality of Life Questionnaire asks patients questions specific to rhinitis alone, usually nonallergic rhinitis. The questionnaire is similar to the RQLQ except there is no assessment of associated eye symptoms [31].

The Nocturnal Rhinoconjunctivitis Quality of Life Questionnaire focuses on the impairments in patients with nighttime symptoms and assesses specific problems that interfere with sleep. The Nocturnal Rhinoconjunctivitis Quality of Life Questionnaire assesses 16 items in four domains, with three domains focusing on sleep and one on daytime symptoms. The four domains include problems with sleep, symptoms during sleep time, symptoms on waking in the morning, and practical problems [32].

Sleep specific questionnaires

General questionnaires that examine quality of sleep and daytime somnolence include but are not limited to the Epworth Sleepiness Scale (ESS) [33,34], the Pittsburgh Sleep Quality Index (PSQI) [35], the Calgary Sleep Apnea Quality of Life Index (CSAQLI) [36], and the University of Pennsylvania Functional Outcomes of Sleep [37]. Unfortunately, these questionnaires have poor sensitivity for sleep disturbance associated with rhinitis and thus may be inadequate in their analysis of mild-to-moderate sleep impairment characteristic of allergic rhinitis.

The ESS is a simple, inexpensive, self-administered questionnaire used to measure the general level of daytime sleepiness in a patient. Questions are asked on a zero to three point scale to evaluate the likelihood of falling asleep during eight daytime situations. Although the ESS is frequently used to assess sleep in persons with rhinitis there is a lack of correlation with polysomnography. In addition, the instrument was designed to assess daytime sleepiness in patients with sleep apnea and may not be sensitive enough to use in assessing rhinitis or response to therapy [33,34].

The PSQI is a self-administered questionnaire designed to measure sleep quality and disturbances over a 1-month time interval. Nineteen items generate scores in seven component areas including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, the use of sleep medications, and daytime dysfunction. This instrument was designed and is most useful in psychiatric clinical practice and research activities [35].

The CSAQLI is a quality of life questionnaire, which measures components of quality of life important to sleep apnea patients. The CSAQLI uses a seven-point scale to measure items in five domains including normal daily routine, social interactions, emotional functioning,

Table 2 Objective health-related quality of life instruments

Instrument	Domains measured	Effect from rhinitis	Effect with treatment	Citations
Peak Nasal Inspiratory Flow	Nasal inspiratory flow	Decreased	Increased with intranasal corticosteroid, antihistamine, and decongestant	[38,39,41]
Acoustic rhinometry	Nasal obstruction Nasal patency	Decreased	Increased with intranasal corticosteroid, antihistamine, and decongestant	[38–40,42]
Rhinomanometry	Nasal obstruction Nasal patency	Decreased	Increased with intranasal corticosteroid, antihistamine, and decongestant	[38,39,41,42,53]
Polysomnography	Nasal obstruction Upper airway obstruction	Increase in AHI	Decrease in AHI with intranasal corticosteroid and leukotriene modifier	[11,43–50,53–55,68]
Multiple Sleep Latency Test	Sleep Tendency to fall asleep			[56,57]
Maintenance of Wakefulness Test	Ability to stay awake			[56–59]
Learning assessment	Learning impairment associated with allergic rhinitis and treatment	Decreased	Increased with intranasal corticosteroid and nonsedating antihistamine	[60–63]
Performance testing	Performance related to allergic rhinitis and treatment of symptoms	Decreased	Increased with nonsedating antihistamine	[64,65]

AHI, apnea–hypopnea index.

symptoms, and treatment-related symptoms. The CSAQLI discriminates between patients in whom sleep apnea has a significant impact on the quality of life compared to those in whom sleep apnea has little effect [36].

The University of Pennsylvania Functional Outcomes of Sleep (FOSQ) was developed to measure how excessive sleepiness affects a patient's ability to conduct normal daily activities as well as the extent to which these abilities are improved through treatment. The FOSQ is a 30-item self-administered questionnaire. Five domains including activity level, vigilance, intimacy and sexual relationships, general productivity, and social outcome are measured to determine the individual's functional status [37].

Objective instruments

Skin prick testing and evaluation of specific IgE levels identify specific allergens leading to symptoms, but additional studies can be useful in the evaluation of sleep-related dysfunction associated with allergic rhinitis. Nasal challenge to allergen can establish the diagnosis of allergic rhinitis when other diagnostic tools, such as skin prick testing and specific IgE, are inconclusive [38]. Evaluation of nasal patency and physiology in rhinitis can aid in the diagnosis of the complete nasal evaluation [39]. Peak nasal inspiratory flow, acoustic rhinometry, and rhinomanometry are tools available to assess the nasal airway [40]. Measurement of nasal congestion in addition to polysomnography, the Multiple Sleep Latency Test, the Maintenance of Wakefulness Test, and learning and

performance testing are helpful in the assessment on the effect of allergic rhinitis on sleep. A number of objective instruments are summarized in Table 2.

Peak nasal inspiratory flow

Peak nasal inspiratory flow is an easy and inexpensive means of measuring nasal obstruction and correlates significantly with severity of symptoms scores. Peak nasal inspiratory flow is possibly the best validated technique for home monitoring in clinical trials. A modified peak flow meter, a Youtlen peak nasal inspiratory flow meter, is utilized for testing. An anesthesia mask is placed over the nose and mouth and the patient inspires forcefully through the nose while the lips remain tightly closed. Readings are effort dependent, thus reproducibility is a concern [39,41]. This instrument has been used successfully in comparative pharmaceutical studies [39].

Acoustic rhinometry

Acoustic rhinometry is a nonphysiological measure of nasal patency used in the clinical or research setting to evaluate nasal obstruction. Acoustic rhinometry is simple to perform and requires little patient cooperation. Acoustic rhinometry does not measure flow resistance nor pressure, but rather the internal nasal luminal volume and cross-sectional area of the nasal airway. Sound waves are passed into the nose and analyzed to determine the area in the nasal cavity. The measured nasal volume correlates well with imaging studies [38–40,42]. Nasal allergen provocation studies demonstrate a high specificity and sensitivity in the evaluation of the allergic response [38].

Rhinomanometry

Rhinomanometry is the technique of choice used to measure nasal patency and assesses the patency of the nose by measuring airflow at a pressure of 75 Pa to determine nasal airway conductance. While wearing a mask, a seal is obtained around the patients' nose. The patient must be cooperative, testing cannot be performed if one nasal passage is completely obstructed, and multiple measurements are required [39,41,42]. This nasal measurement is used in clinical studies to determine changes in mucosal patency associated with congestion [39]. This form of objective assessment is often described by subjects as uncomfortable; thus, is often replaced by less invasive techniques.

Polysomnography

Snoring and obstructive sleep apnea (OSA) associated with the consequences of rhinitis and upper airway obstruction lead to poor sleep [11,43–47]. A small number of studies are available to assess the effect of allergic rhinitis on sleep using objective measurements during polysomnography [11,43–50].

Polysomnography is considered the gold standard for the diagnosis of sleep disorders. Polysomnography records sleep stages, respiratory effort, airflow, oxygen saturation, body position, and leg movements during sleep. The information collected determines the patient's sleep stages, number of arousals, apneas, hypopneas, and possible leg movement disorder. Microarousals apnea index (number of apneas per hour), hypopnea index (number of hypopneas per hour), apnea–hypopnea index (AHI), snoring time, amount of REM sleep, and sleep latency are recorded [51,52].

Increased sleep disordered events lead to poor sleep with fatigue, daytime somnolence, and impaired performance. An increase in nasal resistance in symptomatic patients with allergic rhinitis correlates with an increase in the AHI [45]. Further, treatment with intranasal corticosteroids caused a decrease in nasal airflow resistance with a decrease in AHI in both adults [53] and children [49]. Intranasal corticosteroid therapy is recommended as an adjunct therapy in the treatment of OSA for patients with rhinitis [54]. Improvement in subjective sleep scores following intranasal corticosteroid therapy include decreased severity of congestion, significantly decreased sleep problems, and significantly decreased daytime sleepiness compared with placebo, but improvement in symptoms does not always correlates with polysomnography [55].

The advantage of polysomnography in the evaluation of allergic rhinitis and sleep includes the objective data obtained on sleep quality, but several disadvantages to the use of polysomnography should be considered. Polysomnography is expensive and time consuming for the

patient and evaluator. Subjective instruments and polysomnography do not always correlate and polysomnography may not provide data that questionnaires do. Because of the expense and time requirement associated with polysomnography, the study should be reserved for research, children with snoring and daytime symptoms, adults with daytime somnolence and fatigue, and those with apparent disturbed sleep.

Multiple Sleep Latency Test

The Multiple Sleep Latency Test (MSLT) is a validated objective measure of the tendency to fall asleep under standardized conditions in the absence of external factors. It is the standard tool for assessing excessive daytime sleepiness. The test measures how quickly sleep occurs during quiet periods during the day. Electroencephalogram, electrooculograms, electromyogram, and electrocardiogram are recorded during the test [56,57].

The MSLT is indicated in the evaluation of patients with suspected narcolepsy and idiopathic hypersomnia. The MSLT is not routinely indicated in the initial evaluation of obstructive sleep apnea or in assessment of change following treatment with nasal continuous positive airway pressure, insomnia, circadian rhythm disorders, or in medical and neurological disorders other than narcolepsy [56,57]. It may, however, be a great tool to demonstrate changes in daytime somnolence during therapeutic trials. As of yet, few data exist on the effect of rhinitis on the MSLT.

Maintenance of Wakefulness Test

The Maintenance of Wakefulness Test (MWT) is a validated objective measure of the ability to stay awake and is used to assess the ability to maintain wakefulness. The MWT may be indicated in individuals with excessive sleepiness to assess response to treatment. The MWT is often used when the ability of an individual to remain awake is a safety concern and often MWTs are performed for medico-legal reasons related to concern for public or personal safety. The MWT consists of a 40-min protocol in which the patient is placed in the sitting position and instructed to sit still and remain awake for as long as possible. Four trials are performed at two-hour intervals. Electroencephalogram (EEG), electrooculograms (EOGs), electromyogram (EMG), and electrocardiogram (EKG) are recorded during the test [56–59]. As of yet, no data are available on how rhinitis affects MWT or if therapy results in a significant change.

Learning assessment

During the allergy season, patients with allergic rhinitis exhibit a significant decline in cognitive processing, psychomotor speed, verbal learning, memory, as well as increased sleep disturbances, depressive feelings, feelings of insufficiency, and complaints of somatization [60].

Untreated children with allergic rhinitis and children treated with diphenhydramine allergic rhinitis consistently demonstrate impairment in learning compared to nonallergic controls [61–63]. Questionnaires reveal frustration and embarrassment and overall lower quality of life scores compared to nonallergic controls [62]. Unfortunately, testing learning is complicated and time consuming and requires experts for accurate administration and interpretation [61].

Performance testing

Although poor control of allergic rhinitis symptoms can lead to sedation, nonprescription and prescription medications used to treat symptoms can cause drowsiness and impair performance in everyday tasks. Some H₁-antihistamine receptor antagonists are documented to cause drowsiness and decreased mental performance. Participants treated with placebo and fexofenadine demonstrated similar driving abilities in the Iowa Driving Simulator. Coherence was significantly better after taking fexofenadine and even alcohol as compared with diphenhydramine [64,65].

Conclusion

Numerous studies demonstrate that rhinitis can lead to sleep disordered breathing and poor sleep quality [66]. As a result, those affected suffer from daytime somnolence and fatigue with decreased cognitive and psychomotor abilities and increased difficulty concentrating, impaired learning and memory, impaired work performance and decreased productivity [2,3^{••},4[•],5,6,8–16]. Therapeutic interventions have demonstrated improvement in symptoms and quality of life through subjective and objective instruments. In particular, intranasal corticosteroids improve nasal congestion, daytime fatigue, sleepiness, and sleep disturbances [49,53,55,67]. Subjective and objective instruments demonstrate that antihistamines improve symptoms, but non-sedating antihistamines are preferred as sedating antihistamines can worsen drowsiness and lead to further impairment of cognitive function and learning in children [61] and driving abilities in adults [64]. Leukotriene receptor antagonists demonstrate improvement in sleep and quality of life when used as monotherapy [68] or in combination with antihistamines in patients with allergic rhinitis and sleep-disordered breathing [69]. Although allergy immunotherapy is often recommended to patients unresponsive to other therapies, there are minimal data available on the effectiveness in improvement in sleep impairment [70]. The continued use of subjective and objective instruments will remain helpful and necessary in the evaluation of rhinitis and its effect on sleep.

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References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- of special interest
- of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 290).

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