Snoring, Daytime Sleepiness, and Nasal Obstruction With or Without Allergic Rhinitis

Nobuaki Hiraki, MD; Hideaki Suzuki, MD, PhD; Tsuyoshi Udagka, MD; Teruo Shiomori, MD

Objective: To investigate the relationships among nasal obstruction (NO), snoring, and excessive daytime sleepiness (EDS) in working people with or without allergic rhinitis (AR).

Design: Prospective study using questionnaires.

Setting: An industrial company in Japan.

Participants: We asked 1878 daytime workers to complete questionnaires; data from 1459 respondents were analyzed. Participants were divided into 3 groups: those with NO plus AR, those with NO without AR, and those with AR without NO. Individuals without NO or AR served as controls.

Main Outcome Measures: Allergic rhinitis and daytime sleepiness were evaluated using the European Community Respiratory Health Survey questionnaire and the Epworth Sleepiness Scale, respectively.

Results: The percentage of snorers, the Epworth Sleepiness Scale score, and the percentage of participants with EDS were higher in the NO-AR and NO groups but were not significantly different in the AR group compared with the control group. These variables did not differ between the NO-AR and NO groups. Patients in the NO-AR and NO groups had higher odds of snoring and of having EDS, whereas the odds of snoring or of having EDS were not statistically significant in the AR group compared with the control group (P = .67 and P = .3, respectively).

Conclusions: Nasal obstruction is associated with snoring and EDS in individuals with or without AR. Allergic rhinitis without NO is not associated with sleep-disordered breathing or EDS.


NASAL OBSTRUCTION (NO) is one of the most troublesome symptoms of nasal and paranasal sinus diseases, such as acute and chronic rhinosinusitis, allergic and nonallergic rhinosinusitis, septal deviation, nasal polyps, nasal valve collapse, turbinate hypertrophy, and neoplasms of the nasal cavity. People with NO often experience other symptoms, including headache, thirst, lack of concentration, daytime cognitive deficits, daytime sleepiness, and disturbed sleep, which impair their daily and social activities.1-3 There has been growing awareness that the morbidity of allergic rhinitis (AR) in the general population is increasing and is leading to a decline in school and work performance, resulting not only in a medical economic loss but also in a large social economic loss.4-6 It is well known that patients with AR often experience daytime sleepiness7-9; however, the contribution of NO to this phenomenon has not been well understood. It has also been reported that the severity of NO positively correlates with daytime sleepiness,1 but its mechanism and relation to AR remain unclear. Herein, we performed a questionnaire survey in an attempt to clarify the relationships among NO, snoring, and daytime sleepiness in working people with or without AR.

METHODS

PARTICIPANTS

Daytime employees of a machine manufacturing company in Wakayama prefecture in Japan were enrolled in this study. All of the participants were full- or part-time daytime workers; workers on rotating shifts and permanent night-shift workers were excluded from this study. Of 1878 participants asked to complete the questionnaire, 1615 responded (response rate, 86.0%). Individuals whose questionnaires had any missing answers were then excluded, and 1542 were subjected to further analysis (82.1% of all participants). Participants were divided into 4 groups: the NO-AR group consisted of individuals with NO plus AR, the NO group consisted of individuals with NO without AR, and the AR group consisted...
of individuals with AR without NO. Participants without NO or AR served as controls. Measurements of the participants’ height and weight were obtained from periodic health examinations. The survey was performed in spring, which is the season of Japanese cedar pollinosis. This study was approved by the institutional review board of the University of Occupational and Environmental Health.

QUESTIONNAIRE

The details of the questionnaire are shown in the Figure. Questions A and B are about the frequency of self-reported NO and snoring, respectively, in the past month. The participants were asked to choose 1 of the following 3 responses to these questions: “always/often,” “sometimes,” and “never/rarely.” The “always/often” and “sometimes” responses were considered to be positive. Questions C, D, and E are about the presence of AR, which was evaluated using the European Community Respiratory Health Survey questionnaire according to previous population-based studies9,10 with modifications. Respondents who answered in the affirmative to 1 or more of these 3 questions were considered to have AR. Question F is about the long-term use of medications that might cause sleepiness. Finally, question G is about daytime sleepiness, which was assessed using the Epworth Sleepiness Scale (ESS).10

The survey provided the results of a multiple logistic regression model used to estimate adjusted odds ratios and 95% confidence intervals for snoring and EDS in the 4 study groups. Patients in the NO-AR and NO groups were 2.51 and 2.14 times more likely to snore, respectively, compared with control subjects. Similarly, patients in the NO-AR and NO groups were 1.64 and 1.68 times more likely to have EDS, respectively, compared with control subjects. However, in the AR group, the odds ratio for either snoring or EDS was not statistically significant. These results indicate that NO, regardless of the presence of AR, is likely to be associated with snoring and EDS and that AR without NO is not associated with snoring or EDS.

STATISTICAL ANALYSIS

Data are expressed as mean (SD). All analyses were performed using a statistical software program (SPSS version 11.0; SPSS Inc, Chicago, Illinois). The statistical significance of the differences in the means and ratios was tested using 1-way analysis of variance and the χ² test, respectively. One-way analysis of variance was further assessed using the post hoc Scheffe multiple comparisons test. Multiple logistic regression analysis was used to assess the strength of association between factors. Odds ratios, 95% confidence intervals, and P values were calculated and were adjusted for 3 potential confounding factors (age, sex, and body mass index [calculated as weight in kilograms divided by height in meters squared]). Differences were considered significant at P<.05.
This questionnaire survey showed that the percentage of snorers, the ESS score, the percentage of patients with EDS, and the odds ratios for snoring and EDS were higher in participants with NO than in those without NO regardless of the presence of AR. Allergic rhinitis without NO was not associated with sleep-disordered breathing (SDB) or EDS.

Previous investigators have shown an association between AR and daytime sleepiness. Young at al found that individuals with symptoms of rhinitis were significantly more likely to have daytime sleepiness than were those without such symptoms. Stuck at al also reported that the ESS scores of patients with seasonal AR increased according to the severity of the disease; that is, the more severe the disease, the higher the ESS score. Moreover, Craig et al demonstrated that the use of topical intranasal corticosteroids in patients with perennial rhinitis brought about improvements in sleep quality, the apnea-hypopnea index, and the odds ratios for snoring and EDS were higher in participants with NO than in those without NO regardless of the presence of AR. Lofaso et al reported that patients with SDB often show higher levels of nasal airway resistance than do healthy individuals. In addition, experimental nasal occlusion in healthy subjects induces SDB and frequent arousals and apneas during sleep. Zwillich et al showed that artificial nasal occlusion by means of balloon cannula was associated with an increase in the number of episodes of apnea and arousal during sleep. Millman et al also found that nasal packing led to an increase in the apnea-hypopnea index, apnea duration, and sleep fragmentation. These lines of evidence indicate that NO itself significantly affects breathing during sleep.

Nasal obstruction is thought to induce SDB via several mechanisms. First, increased nasal airway resistance generates increased negative inspiratory force and pressure to maintain a constant airflow, causing the collapse of the oropharynx. Second, the possible transition from nasal breathing to mouth opening and oral breathing leads to inferior movement of the mandible and hyoid bone and then to the backward fall of the base of the tongue, thus narrowing the pharyngeal space. Third, a reduction in nasal airflow attenuates stimulation of the nasal sensory receptors that regulate the tone of the pharyngeal dilator muscles. Under such conditions, respiratory effort increases and, thus, the arousal threshold drops. Fourth, a decrease in stimulation of the nasal sensory receptors directly suppresses the respiratory rate.

We used the European Community Respiratory Health Survey questionnaire to evaluate the presence of AR. This is a well-validated instrument for the screening of AR, and the presence of AR as determined using this questionnaire shows a close correlation with that determined using the skin prick test. In the present study, approximately a quarter of the participants were estimated to have AR (Table 1), a finding that is generally consistent with previous surveys using clinical laboratory tests that reported the prevalence of AR in Japan to be 25% to 40%. Of the allergic manifestations, NO is a common and annoying symptom that occurs in more than 50% of patients with AR. The present study showed that NO was reported in more than two-thirds of participants with AR and in approximately one-third of those without AR (Table 1). Such

### Table 2. Snoring and Daytime Sleepiness in Relation to Nasal Obstruction (NO) and Allergic Rhinitis (AR)

<table>
<thead>
<tr>
<th>Group</th>
<th>NO-AR (n=250)</th>
<th>NO (n=359)</th>
<th>AR (n=111)</th>
<th>Control (n=739)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snorers, No. (%)</td>
<td>159 (63.6)</td>
<td>231 (64.3)</td>
<td>49 (44.1)</td>
<td>327 (44.2)</td>
</tr>
<tr>
<td>ESS score, mean (SD)</td>
<td>7.4 (3.7)</td>
<td>7.8 (3.6)</td>
<td>7.0 (3.7)</td>
<td>6.7 (3.4)</td>
</tr>
<tr>
<td>Participants with EDS, No. (%)</td>
<td>49 (19.6)</td>
<td>73 (20.3)</td>
<td>18 (16.2)</td>
<td>92 (12.4)</td>
</tr>
</tbody>
</table>

Abbreviations: EDS, excessive daytime sleepiness (defined as an Epworth Sleepiness Scale score ≥11); ESS, Epworth Sleepiness Scale.

### Table 3. Multiple Logistic Regression Model of Snoring and EDS

<table>
<thead>
<tr>
<th>Group</th>
<th>Snoring Odds Ratio (95% CI)</th>
<th>P Value</th>
<th>EDS Odds Ratio (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (n=739)</td>
<td>1 [Reference]</td>
<td>NA</td>
<td>1 [Reference]</td>
<td>NA</td>
</tr>
<tr>
<td>AR (n=111)</td>
<td>1.10 (0.70-1.70)</td>
<td>.67</td>
<td>1.34 (0.77-2.33)</td>
<td>.3</td>
</tr>
<tr>
<td>NO (n=359)</td>
<td>2.14 (1.60-2.86)</td>
<td>&lt;.001</td>
<td>1.68 (1.19-2.37)</td>
<td>.003</td>
</tr>
<tr>
<td>AR-NO (n=250)</td>
<td>2.51 (1.80-3.49)</td>
<td>&lt;.001</td>
<td>1.64 (1.14-2.40)</td>
<td>.01</td>
</tr>
</tbody>
</table>

Abbreviations: AR, allergic rhinitis; CI, confidence interval; EDS, excessive daytime sleepiness (defined as an Epworth Sleepiness Scale score ≥11); NA, not applicable; NO, nasal obstruction.

Data are adjusted for age, sex, and body mass index.

Snoring is indicated by the answer “always/often” or “sometimes.”
a high prevalence of AR and NO implies that many people in the general population are faced with the risk of a decline in sleep quality and daytime performance, suggesting that there is an urgent need for the comprehensive management of sinonasal diseases.

Some potential limitations should be considered when interpreting the present results. First, the question about snoring sought to obtain estimation from participants’ spouses or partners but was completed by the participants themselves, who may have biased the estimation. From this standpoint, we may have misestimated snoring. Accordingly, participants’ family members should be blinded to the participants and should be directly asked this question in a future study. Second, because the present survey was not population based but was occupation based, the participants consisted predominantly of middle-aged men, a typical working population in Japan, who are likely to snore more. Third, multiple factors participate in the occurrence of snoring: obesity, aging, male sex, smoking, alcohol consumption, NO, anatomical pharyngeal narrowing, craniofacial abnormalities, and so forth. However, all potential risk factors were not examined in this study. Further studies with several different designs remain to be performed to overcome such weak points.

In conclusion, this questionnaire survey in a general working population revealed that NO is associated with snoring and daytime sleepiness in individuals without AR and in those with AR and that AR is not associated with SDB or daytime sleepiness unless NO is present. We speculate that, although NO itself is not a life-threatening condition, prompt and appropriate rhinologic treatment would improve sleep quality and, thus, daily and social activities in patients with sinonasal diseases. This remains to be further investigated in future studies.

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Correspondence: Hideaki Suzuki, MD, PhD, Department of Otorhinolaryngology, School of Medicine, University of Occupational and Environmental Health, 1-1 Iseigaoka, Yahatanishi-ku, Kitakyushu 807-8555, Japan (suzuyhyde@med.ueh-u.ac.jp).

Author Contributions: All authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Hiraki and Udaka.

Acquisition of data: Hiraki.

Analysis and interpretation of data: Hiraki, Suzuki, Udaka, and Shimomori.

Drafting of the manuscript: Hiraki, Suzuki, and Udaka.

Critical revision of the manuscript for important intellectual content: Hiraki, Udaka, and Shimomori.

Statistical analysis: Hiraki and Udaka.

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REFERENCES