




Investigating the Differences in Polysomnography Results Evaluated According to the Recommended and Alternative Hypopnea Criteria Utilized in the Evaluation of Polysomnography

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Abstract

OBJECTIVE: The criteria of hypopnea recommended by the American Academy of Sleep Medicine until 2012 was 3% desaturation and 50% decline in the signal amplitude. The recommended and alternative criteria for hypopnea were determined as 3% desaturation accompanied by a 30% decline in the signal amplitude and 4% desaturation accompanied by a 30% decline in the amplitude by the 2013 update of the guideline was published by the American Academy of Sleep Medicine in 2012. The objective of our study was to investigate to what degree scoring of hypopneas has great importance in the diagnosis and severity grading of obstructive sleep apnea syndrome according to different criteria.

MATERIAL AND METHODS: The present study was designed as a retrospective study in which the results of the polysomnography of 62 patients were recorded after evaluation according to 3 different hypopnea criteria. Criteria 1, criteria 2, and criteria 3 were accepted as a 3% drop in SaO₂ accompanied by a 30% decline in the amplitude, as a 4% drop in SaO₂ accompanied by a 30% decline in the amplitude, and as a 3% drop in SaO₂ accompanied with a 50% decline in the amplitude, respectively.

RESULTS: Statistically significant differences were determined between criteria 1 and criteria 2, criteria 1 and criteria 3, and criteria 2 and criteria 3 regarding the numbers of hypopneas.

CONCLUSION: For the same polysomnography, evaluations with different accepted hypopnea criteria cause different polysomnography results.

KEYWORDS: Hypopnea, hypopnea criteria, AASM, OSAS, polysomnography

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INTRODUCTION

Obstructive sleep apnea syndrome (OSAS) is a syndrome characterized by an intermittent complete or partial obstruction of the upper airway during sleep accompanied by a decline in blood oxygen saturation and arousals. Polysomnography (PSG) is the gold standard for the diagnosis of OSAS.^{1,2} PSGs were performed due to prediagnosis of OSAS in the context of sleep laboratories. Therefore, monitorization of respiratory parameters in PSG and scoring respiratory records bears great importance. The apnea-hypopnea index (AHI) is the number of apneas and hypopneas monitored per hour during sleep. Taking into consideration the fact that AHI is employed in the diagnosis and severity grading of the diseases, hypopnea features equivalent importance with apnea.

Only apneas were scored in the years of first PSG recordings, while hypopneas were noticed during the later years. Hypopnea was first referred to in 1987 in the study of Gould, and it has been defined as oxygen desaturation associated with reduced blood flow.³ Many studies have been conducted addressing the definition of hypopnea over the next 11 years. The first standardization was carried out by the American Academy of Sleep Medicine (AASM) in 1999, and "Chicago Criteria" were recommended for scoring respiratory events. The AASM has revised scoring criteria intermittently, and current data were added as of 2007 and 2013.^{4,6} Following the establishment of 2 different hypopnea criteria during 2007, 2 different hypopnea criteria were presented as of 2013 as "recommended" and "alternative." This preferred option provided to the scorer for hypopnea refers to 2 different results for an identical patient, and that situation may lead to a false diagnosis and treatment, unnecessary testing, extra costs accompanied by serious patient injustices due to comorbidities, and complications.

While PSG is already a test which may exhibit different results at different times even as a result of the identical scorer, an alternative hypopnea criterion presented by the guideline makes assessment further complicated. The studies carried out during recent years advocate for hypopnea criteria being standardized soon.

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The objective of this study is to present that scoring hypopnea according to different criteria gives rise to different results, and that this dilemma instigates differences in the treatment decision-making process.

MATERIAL AND METHODS

Study Design and Settings

Between January and February 2020, 80 consecutive patients were selected who had applied to an Outpatient Clinic for Sleep of The Department of Pulmonary Diseases and provided their written and undersigned voluntary consent forms. Due to clinical findings which suggest OSAS such as snoring, excessive daytime somnolence, and witnessed apnea, the patients have undergone PSG recordings at the sleep laboratory. Those PSGs with insufficient sleep duration and technical unavailability were excluded from the study. A retrospective study which featured the PSGs of the rest 62 patients was carried out.

The study was approved by Istanbul University-Cerrahpasa, Cerrahpasa Medical Faculty Clinical Research Ethics Committee (no. E-83045809-604.01.02-2627).

Participants

The inclusion criteria were determined as the presence of OSAS symptoms, and PSG recordings were performed due to the prediagnosis of OSAS.

The exclusion criteria were determined to be technically erroneous PSG recording and insufficient sleep duration (minimum sleep duration was accepted as 240 minutes).

Data Collection

Polysomnography Data: All patients were hospitalized overnight in the pulmonary diseases sleep unit. Polysomnograms were recorded over the course of 8 hours of monitoring.

The minimum requirements for PSG were reported in the AASM 2007 report which involves the consensus with the highest attendance until the present time, and the recording protocol was based on this report.⁵ Monitorizations were performed utilizing electroencephalogram (C3/A2, C4/A1, Fp1/A1, Fp2/A2, O1/A1, O2/A2), electrooculogram (right and left), chin and 2 legs electromyogram, electrocardiogram, nasal cannula, thermistor, tracheal microphone, body position, oximetry, and respiratory effort channels.

Polysomnography recordings were performed using the SOMNOscreen plus system (SOMNOmedics GmbH, Randersacker, Germany).

The PSG recording of each patient was scored by the same certified scorer according to the standards, by blind scoring.⁶ The scores of the respiratory events were evaluated according to different hypopnea criteria and the results were thusly recorded.

Apnea–Hypopnea Index: The AHI was determined to be a mild OSAS if between 5 and 14, moderate OSAS if between 15 and 29, severe OSAS if ≥ 30 .

Criteria 1, as recommended in AASM 2013, required a $\geq 3\%$ decline in oxygen saturation accompanied by a $\geq 30\%$ decline in the amplitude of the nasal airflow.

Criteria 2, as the recommended alternative criteria in AASM 2013 and the recommended criteria also in the AASM 2007, required a $\geq 4\%$ decline in oxygen saturation accompanied by a $\geq 30\%$ decline in the amplitude of the nasal airflow.

Criteria 3, recommended as the alternative criteria in AASM 2007, required a $\geq 3\%$ decline in oxygen saturation accompanied by a $\geq 50\%$ declined in the amplitude of the nasal airflow.

Statistical Analysis

Standard software was used for the Statistical Package for Social Sciences, version 10.0 software (SPSS Inc.; Chicago,IL, USA). Mean and standard deviation were calculated for the continuous variables with a normal distribution, while median value was calculated for the continuous variables with non-normal distribution. The categorical variables were expressed as percentages. Mann–Whitney *U* test and Chi-square tests were used for comparison of the groups. The statistical significance level was accepted as $P < .05$.

RESULTS

Participant

Of the 62 patients included in the study, 16 (25.8%) were female and 46 (74.2%) were male. The mean age was 50.1 ± 13.4 years. Sleep activity was found to be $79.5 \pm 13.4\%$.

Descriptive Data

Apnea–hypopnea indices and the number of hypopneas according to criteria 1, criteria 2, and criteria 3 were detected to be 31.1 ± 25.8 (median: 22.5) and 99.9 ± 82.7 (median: 88.5); 26.1 ± 26.0 (median: 17) and 61.5 ± 53.8 (median: 44), and 25.7 ± 25.7 (median: 17) and 66.9 ± 57.4 (median: 57.5), respectively.

Statistically significant differences were determined between criteria 1 and criteria 2 ($P < .001$), criteria 1 and criteria 3 ($P < .001$), and criteria 2 and criteria 3 ($P = .024$) regarding the numbers of hypopneas, respectively.

Outcome Data

Compared with respect to AHI, statistically significant differences were noted between criteria 1 and criteria 2 ($P < .001$), and criteria 1 and 3 ($P < .001$). The difference between criteria 2 and criteria 3 was not statistically significant ($P > .05$).

The numbers of the hypopneas and AHI values were compared according to the evaluation based on 3 different criteria in Table 1.

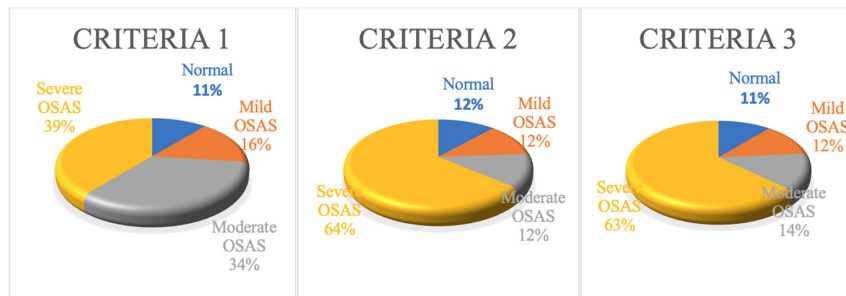
MAIN POINTS

- The hypopnea criterion was suggested by the American Academy of Sleep Medicine.
- Two different hypopnea evaluation methods were proposed as the recommended and alternative criteria.
- Different results occur for the same polysomnography.
- Consensus should be reached on an accepted single criterion for the definition of hypopnea.

Table 1. The Numbers for Hypopnea and AHI Values According to 3 Different Criteria

	Criteria 1	Criteria 2	Criteria 3	P
The numbers of the hypopneas	99.9 ± 82.7	61.5 ± 53.7	66.9 ± 57.4	<.001
AHI values	31.1 ± 25.8	26.1 ± 26.0	25.7 ± 25.7	<.001

AHI, apnea–hypopnea index.

**Figure 1.** Distribution of AHI values and OSAS severity according to different scoring criteria. AHI, apnea–hypopnea index; OSAS, obstructive sleep apnea syndrome.

The use of different scoring methods created different AHI values and different outcomes in the diagnosis and severity grading of OSAS (Figure 1). The number of the patients evaluated to be normal was 7 (11%) according to criteria 1 whereas the numbers of those patients according to criteria 2 and criteria 3 were 14 (22.6%) and 13 (21.0%), respectively. The rates of mild, moderate, and severe OSAS according to criteria 1 were 16%, 34%, and 39%, respectively, whereas those rates were 12%, 12% and 64% according to criteria 2, respectively, and 12%, 14%, and 63% according to Criteria 3, respectively. The difference between criteria 1 and both criteria 2 and criteria 3 with respect to the number of the patients evaluated was found to be normal ($P < .05$ and $P < .05$, respectively). No statistically significant difference was found between criteria 2 and criteria 3 ($P > .05$).

DISCUSSION

In the present study, the impact of the difference between AHIs on diagnosis and the severity grading of OSAS was analyzed by means of performing respiratory scorings according to 3 different hypopnea definitions declared by the AASM in 2007 and 2013 for standardization.

The AASM 2013 recommended, 2013 alternative/2007 recommended, and 2007 alternative criteria were named criteria 1, criteria 2, and criteria 3, respectively. It was found that the number of the patients evaluated to be normal according to criteria 1 was 7 (11.3%), whereas the number of those patients was 14 (22.6%) and 13 (21%) according to criteria 2 and criteria 3, respectively. Accordingly, scoring hypopneas according to the recommended criteria by the AASM 2013 revealed a significant change in AHIs, an increased prevalence rate of OSAS, and a significant decline in the number of the patients evaluated as normal. This indicates that a patient diagnosed with OSAS according to the recommended criteria may be evaluated as normal according to the alternative criteria.

In 1999, the AASM produced the first consensus report consisting of respiratory scoring criteria, and this standardization

was based on clinical studies.^{7,8} The definition of hypopnea was created in 2001.⁹ In 2005, the AASM, via the Practice Parameters Committee, reported that “Several clinical definitions of hypopnea are in clinical use and there is no clear consensus.”¹⁰ Standardization to recommended and alternative criteria was published as the “Manual for the Scoring of Sleep and Associated Events” in 2007.¹¹ These new standards have led to different results in different laboratories.

In a similar study in 2008, Ruehland et al³ has used 1999 Chicago Criteria and AASM 2007 criteria for hypopnea and pointed out the changes in AHIs due to the use of different hypopnea definitions and emphasized that there was a lack in terms of standardization, which would influence the identification, grading, and treatment decision processes of the diseases. This conclusion indicates the importance of standardization of the results based on single criteria, and many similar studies have supported this conclusion.^{13–16}

In the study of BaHammam et al.¹⁷ a significant difference with respect to detecting hypopnea events exists among the 2012 recommended and alternative definitions. Duce restated in 2015 during his study that respiratory scoring performed according to hypopnea criteria recommended in 2012 increased the incidence of hypopnea. Duce et al¹³ also emphasized that the number of patients diagnosed with OSAS according to AHI value increased. The outcomes of these 2 studies support our data.

These 2 different hypopnea criteria were utilized in another study carried out on patients with chronic heart failure, and significantly higher AHI values were detected according to the recommended criteria compared with the alternative criteria. However, no change was identified in the numbers of obstructive apnea or central apnea.

Hirotsu et al¹⁸ showed up to a 2-fold difference in the AHI level of 2162 participants scored in accordance with the AASM 2007 and AASM 1999/2012 hypopnea criteria, but this was associated with cardiometabolic outcomes.

Despite the importance of AHI in identification and grading, variations between the laboratories in the identification of hypopnea have been noticed.^{12,15,16} The AASM has liberated the clinician or researcher to predict the availability of recommended or alternative hypopnea definitions.⁶

Lacking standardization would likely give rise to varying results with different scorers, furthermore even with the same scorers, at different times and within different sleep laboratories. The number of patients diagnosed with OSAS will increase by scoring according to the 2013 hypopnea recommended criteria. Given that an option of recommended and alternative criteria was not given for diagnosis of hypertension, no option should be recognized for OSAS also.⁸

The limitations of our study include not having a prospective and randomized design. Hence, our study should be considered as a preliminary study.

CONCLUSION

Different hypopnea definitions give rise to different AHIs and consequently influence diagnosis, grading, and treatment decisions. The implementation of different criteria in the assessment of hypopnea significantly affects the number of the patients evaluated to be normal by PSG. This study makes clear to clinicians that different hypopnea definitions could lead to conflicting outcomes and suggests that the definition of hypopnea should be revised based on a single criterion.

Ethics Committee Approval: This study was approved by Ethics committee of İstanbul University-Cerrahpasa, Cerrahpasa Medical Faculty, (Approval No: E-83045809-604.01.02-2627).

Informed Consent: Written informed consent was obtained from all individual participants who were involved in the study.

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