The DES-OSA Score for Identifying Patients with Sleep Apnea: A Validation Study and Suggestions for Improvement

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ABSTRACT **Background:** The DES-obstructive sleep apnea (DES-OSA) score uses morphological characteristics to predict the presence and severity of obstructive sleep apnea syndrome (OSAS).

Objectives: To validate DES-OSA scores on the Israeli population. To identify patients requiring treatment for OSAS. To evaluate whether additional parameters could improve the diagnostic value of DES-OSA scores.

Methods: We performed a prospective cohort study on patients attending a sleep clinic. Polysomnography results were examined independently by two physicians. DES-OSA scores were calculated. STOP and Epworth questionnaires were administered, and data on cardiovascular risk was extracted.

Results: We recruited 106 patients, median age 64 years, 58% male. DES-OSA scores were positively correlated with apnea-hypopnea index (AHI) ($P < 0.001$) and were significantly different between the OSAS severity groups. Interobserver agreement for calculating DES-OSA was very high between the two physicians (intraclass correlation coefficient 0.86). DES-OSA scores ≤ 5 were associated with high sensitivity and low specificity (0.90 and 0.27, respectively) for moderate to severe OSAS. In univariate analysis, only age was significantly correlated with the presence of OSAS (OR 1.26, $P = 0.01$). Age older than 66 years as a single point in the DES-OSA score slightly improved the sensitivity of the test.

Conclusions: DES-OSA is a valid score based solely on physical examination, which may be useful for excluding OSAS requiring therapy. DES-OSA score ≤ 5 effectively ruled out moderate to severe OSAS. Age older than 66 years as an extra point improved the sensitivity of the test.

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KEY WORDS: apnea-hypopnea index, (AHI), DES-obstructive sleep apnea (DES-OSA) score, obstructive sleep apnea syndrome (OSAS), physical examination, polysomnography

Patients with obstructive sleep apnea syndrome (OSAS) experience recurrent obstruction in their airway during sleep, which leads to hypoxia and triggers an awakening response to resume normal breathing [1]. OSAS is a well-known and common condition associated with significant morbidity and mortality due to hypertension, ischemic heart disease, poor glycemic control, and motor vehicle accidents [2,3]. Population prevalence ranges from 38% with mild OSAS to 17% with moderate severity OSAS. Most patients are male and are of older age. In some subgroups, OSAS prevalence can reach up to 90% [4]. In Israel, according to healthcare provider datasets, 4–10% of the male population and 2–5% of the female, experience OSAS, most of whom are in the age range of 35–54 years [5]. Ethnicities were studied previously. Higher prevalence and severity of OSAS was found in Arab adult males compared to their Jewish counterparts [6].

OSAS is diagnosed, and severity is assessed, by polysomnography, which is performed in a sleep laboratory and with home tests. The apnea-hypopnea index (AHI) is derived by observing apneas and hypopneas during polysomnography. This exam may be inconvenient and uncomfortable for the patient and is expensive. There is limited laboratory availability. Therefore, there is interest in evaluating clinical screening tests that will predict the polysomnography results and provide more reasons for referring patients for polysomnography.

Deflandre and colleagues [7] defined a scoring system, DES-OSA, which included only objective morphological features of the patients who underwent polysomnography [Table 1]. Based on their data, a score of 5 points and higher was able to predict both OSAS and severity of the syndrome with a sensitivity and specificity of over 70% for OSAS at all severities. The researchers did not include patient medical history, age, or OSAS symptoms in their score. The DES-OSA score was derived and validated by the authors and seems to perform better than other suggested scoring systems such as STOP-BANG, P-SAP, and OSA50 [8]. However, no external validation of the score has been published.

In the current study, we validated the DES-OSA scoring system on an Israeli population. We also examined whether the addition of other criteria, such as age and medical history, validated questionnaires. We speculated that using the STOP-BANG and Epworth instruments would increase the level of sensitivity and specificity in predicting OSAS [9.10]. We hypothesized that the DES-OSA score would be equally applicable in an Israeli

Table 1. Demographic data grouped by obstructive sleep apnea syndrome severity levels, the components, both original and novel, of the DES-OSA scores grouped by OSAS severity

Number (%)	No OSA (< 5 AHI)	Mild (5–14.9 AHI)	Moderate (15–29.9 AHI)	Severe (› 30 AHI)	*P*-value
Total patients	3 (2)	30 (28.3)	34 (32)	39 (36.7)	
Sex (% males)	0.6	0.73	0.7	0.77	
Age (median)	48 (33–54.5)	60 (48–66.2)	67.5 (57–70)	67 (54–73)	
AHI (median)	2.1 (1.5–2.15)	10.85 (7.07–12.2)	20 (16.97–23.92)	46.1 (36.45–56.1)	
Height in cm	178	168.5	167.5	170	
Weight in kg	77	87.5	86.5	101	
Co-morbidities*					
None	2 (66.6)	10 (33.3)	5 (14.7)	6 (15.4)	
One	0	11 (36.6)	12 (35.3)	10 (25.6)	
Two	1 (33.3)	4 (13.3)	10 (33.3)	8 (20.5)	
More than two	0	5 (16.6)	7 (20.6)	15 (38.5)	
DES-OSA components					
BMI	25.9 (24.95–29.3)	29.395 (26.95–33.5)	29.45 (27.37–33.4)	34.4 (30.0–38.5)	0.0008
Sex (male)	2	22	24	30	0.92
NC (IQR)	37 (36.5–39.1)	40 (38.62–42.57)	40.9 (39.1–43.9)	43.5 (40.75–47.07)	0.004
DTC (IQR)	7.25 (7.12–8)	8.5 (8–8.93)	8.5 (7.8–9.2)	8.75 (8–9.5)	0.13
MP (IQR)	2 (1.5–2.5)	2.5 (2–3)	3 (2–3)	3 (2.5–4)	0.08
DES-OSA score	4 (3–5)	6 (5–7)	7 (5.2–7)	8 (6.5–8)	0.0003
Novel components					
EPWORTH Qst (IQR)	7 (6.5–9.5)	9.5 (6–14.5)	7 (4.2–10.8)	10 (6–12)	0.35
STOP-BANG questionnaire (IQR)	1 (1–1.5)	3 (2–3)	2 (2–3)	3 (2–4)	0.06
Smoking	0	4 (13.3)	5 (14.7)	12 (30.8)	0.28
Hypertension	1 (33.3)	14 (46.6)	15 (44.1)	27 (69.2)	0.1
Ischemic heart disease	0	4 (13.3)	10 (33.3)	11 (28.2)	0.28
Diabetes mellitus	1 (33.3)	9 (30)	11 (32.3)	15 (38.5)	0.89
Hyperlipidemia	0	6 (20)	14 (41.1)	16 (41)	0.12
Age in years	48 (33–54.5)	60 (48–66.2)	67.5 (57–70)	67 (54–73)	0.01

*Co-morbidities included diabetes mellitus, hyperlipidemia, hypertension, ischemic heart disease, and smoking
Continuous data as median (IQR)
AHI = apnea-hypopnea index, BMI = body mass index, DTC = distal thyroid to chin, IQR = interquartile range, MP = Mallampati score, NC = neck circumference, OSA = obstructive sleep apnea, OSAS = obstructive sleep apnea syndrome

population and that the additional factors would improve the predictive power of the score.

PATIENTS AND METHODS

This cohort study was approved by the hospital's Helsinki committee (no. ASF-0141-17).

FACILITY

The testing was performed at the sleep laboratory in the Pulmonology Institute at Shamir Medical Center (Assaf Harofeh), Israel.

POPULATION AND DESIGN

We selected patients over the age of 18 years who were referred to our institute for polysomnography. Home polysomnography tests are not evaluated at our facility and therefore were not in-

cluded in the study. In all cases, the polysomnography was performed and scored by a qualified sleep technician independent of the study physicians. AHI was derived in the accepted fashion. Diagnosis and staging of OSAS was based on AHI values, with standard cutoff levels for determination for OSAS severity. AHI scores ≤ 5 were normal and values of 5–14.9, 15–29.9, and ≥ 30 represented severity levels of mild, moderate, and severe, respectively.

Patients were excluded from the study if their polysomnography results were uninterpretable for any reason, they were referred to the laboratory for non-OSAS diagnosis (e.g., insomnia), or they had been diagnosed with chronic lung disease where hypoxia may not necessarily reflect only OSAS.

Patients attended the clinic to discuss their results and treatment options. During these sessions, the patients underwent a routine physical examination, which included measurement of neck circumference (NC), distance from thyroid to chin (DTC), Mallampati score (MP), and body mass index (BMI, kg/m2). The STOP-BANG and Epworth questionnaires were administered using the official Hebrew translation. We extracted medical history from patient records, including age, sex, smoking history, and cardiovascular risk factors (i.e., hypertension, diabetes mellitus, ischemic heart disease, and hyperlipidemia).

The patients were examined independently by two physicians, who were blinded to the polysomnography results at the time of the examination.

DES-OSA scores were calculated for each participant using the mean value for NC and DTC. MP score was selected for each participant by randomly sampling one score from the two independent measurements.

STATISTICAL ANALYSIS

The sample size was determined as suggested by Collins and co-authors [11,12]. The raw data were summarized as either median (interquartile range) or counts, according to the type of data. Differences between the AHI severity groups were evaluated by chi-square or analysis of variance (ANOVA). Agreement between the independent measurements made by the physicians using Wilcoxon test, Bland Altman analysis, and calculation of the intraclass correlation coefficient (ICC). The primary endpoint of the study was the sensitivity (Sn) and specificity (Sp) to diagnose moderate–severe OSAS (i.e., AHI ≥ 15 at which point treatment is recommended) at different levels of the DES-OSA score. The cutoff level for maximal Sn and Sp together was conducted using the Youden index [13]. Receiver operating curve (ROC) for the DES-OSA score and the presence or absence of AHI were drawn at the optimal level derived from the Youden index. We prospectively planned to model adaptation of the DES-OSA score based on the presence of absence of different risk factors (age, questionnaires, co-morbidities) if they were significantly different between the groups. Statistical analysis was performed using R Statistical Software, version 4.1.0 (R Foundation for Statistical Computing, Vienna, Austria) with the Youden index [13].

The secondary endpoints were correlation between the DES-OSA scores and AHI, demographic data, and questionnaires and by interobserver agreement for calculating the score.

RESULTS

A total of 160 patients were examined at the clinic during the study period. Of the total, 106 were selected according to the inclusion and exclusion criteria. Most of the patients were male (58.4%), with a median age of 60.6 years. In three patients, OSAS was excluded according to the polysomnography with an AHI level ≤ 5. The others were divided according to the severity levels with 30, 34, and 39 participants in the mild, moderate, and severe levels, respectively [Table 1].

PRIMARY ENDPOINT

The gold standard test for the analysis was AHI levels of 15 and higher. Youden index indicated an optimal cutoff DES-OSA of 7 {[(Sn+Sp)-1] = 0.37} with Sn 0.64 and Sp 0.73. We calculated Sn and Sp at each level of DES-OSA [Table 2, Figure 1], which demon-

Table 2. Sensitivity and specificity of varying levels of DES-OSA scores for detecting moderate-severe obstructive sleep apnea syndrome (AHI > 15)

	Threshold values	Sn (95%CI)	Sp (95%CI)	PPV	NPV
AHI > 15 events, n=103	4	0.96 (0.88–0.99)	0.15 (0.05–0.32)	0.71 (0.61–0.80)	0.62 (0.24–0.91)
	5	0.90 (0.81–0.96)	0.27 (0.13–0.46)	0.73 (0.63–0.82)	0.56 (0.30–0.80)
	6	0.79 (0.68–0.88)	0.39 (0.23–0.58)	0.74 (0.63–0.84)	0.46 (0.28–0.66)
	7	0.64 (0.52–0.75)	0.73 (0.54–0.87)	0.84 (0.72–0.92)	0.48 (0.34–0.63)
	8	0.40 (0.28–0.52)	0.91 (0.76–0.98)	0.91 (0.75–0.98)	0.41 (0.29–0.53)

95%CI = 95% confidence interval, AHI = apnea-hypopnea index, DES-OSA = DES obstructive sleep apnea, NPV = negative predictive value, PPV = positive predictive value, Sn = sensitivity, Sp = specificity

Figure 1. DES-OSA scores as a function of obstructive sleep apnea syndrome severity grouped into acceptable grading levels

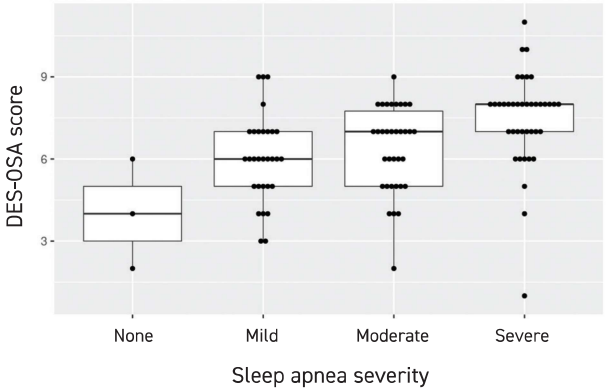
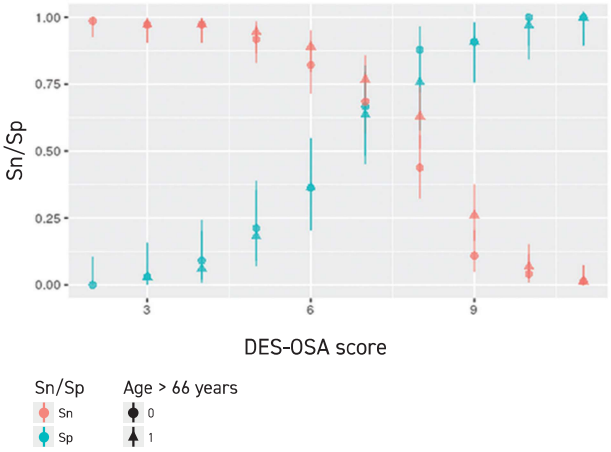


Figure 2. Effect of adding the novel factor age > 66 to the DES-OSA score
OSA = obstructive sleep apnea, Sn = sensitivity, Sp = specificity



strated sensitivity at 90% or more for OSAS at DES-OSA scores ≤ 5 and specificity for the test reaching useful levels of 8 or more.

Based on the finding of positive correlation between age and AHI, we performed a second Youden analysis to determine the optimal cutoff of age between no-mild OSAS and moderate–severe OSAS. This analysis yielded an age of 66 years as the optimal cutoff (Sn 0.56, Sp 0.76). We then examined a modified DES-OSA score where age older than 66 years was scored with an additional one point in the overall score. After adding this factor to the model, at the optimal cutoff of DES-OSA 6, a modest improvement in Sn was observed without a significant change in Sp (0.64–0.76) [Figure 2].

SECONDARY ENDPOINT: CORRELATION WITH AHI, DEMOGRAPHIC, AND QUESTIONNAIRE DATA

Overall, there was a significant positive correlation of the DES-OSA score with OSAS severity. In linear regression of AHI as a function of DES-OSA, a positive correlation was observed, although with significant spread of AHI values around the regression line (Spearman's rho 0.49, P < 0.001). When the DES-OSA scores were grouped by the traditional OSAS severity levels, median DES-OSA scores of 4, 6, 7, and 8 correlated with no OSAS, mild, moderate, and severe levels, respectively (ANOVA $P < 0.001$).

Among the individual DES-OSA score components, both the BMI and NC were shown to have a strong correlation to the severity of the OSAS, with increasing values suggesting a more severe form of the syndrome ($P < 0.001$). The other morphologic features, DTC and MP scores, and the sex of the patient did not show a significant correlation to the severity, although increased MP scores were weakly associated with higher AHI ($P = 0.08$) [Table 1].

Cardiovascular co-morbidities and the STOP-BANG and Epworth questionnaires were not significantly different between the OSAS severity groups, although the STOP-BANG questionnaire was weakly associated ($P = 0.06$) with higher AHI. The age of the patients showed a positive correlation with OSAS severity ($P = 0.01$).

TERTIARY ENDPOINT: INTEROBSERVER AGREEMENT

Interobserver agreement between the two physicians was strong for the DES-OSA score (ICC = 0.86). For the individual components of the DES-OSA score, measurements of DTC had poor agreement between the physicians (ICC 0.39); however, this score did not affect the overall agreement since the minor variations in measurements of DTC were absorbed in the scoring intervals of the DES-OSA score.

DISCUSSION

We performed a cohort study to externally validate the DES-OSA score and to evaluate whether the score can be improved by adding various objective and self-reported parameters. Most of the additional parameters examined, with the exception of age, had no predictive value.

Consistent with the results of Deflandre and co-authors [7], we found that the DES-OSA score correlated with AHI, with increasing scores more predictive of the syndrome and its severity [6]. Also consistent with their previous work, when comparing the DES-OSA score to both STOP-BANG and Epworth questionnaires, the DES-OSA scoring system was stronger in predicting the OSAS [Table 1] [7]. However, we found that the DES-OSA was not able to reliably predict a specific level of OSAS, rather it was useful as a screening tool for ruling out OSAS requiring intervention (AHI ≥ 15). This finding was shown by the high sensitivity levels for DES-OSA score of ≤ 5, where the patients were either in the no OSAS or mild OSAS category. Specificity of the DES-OSA score did not reach diagnostically useful levels until relatively high scores were reached (≥ 8) [Table 2] Age older than 66 years

and adding one point to the DES-OSA score marginally improved the Sn of the score such that a [DES-OSA + age > 66] of 7 had a high Sn to rule out OSAS [Figure 2]. Modifying the DES-OSA66 score to a level of 7 or less may safely exclude OSAS in most cases unless the clinical suspicion is very high. This finding supports the use of DES-OSA as a screening tool by physicians where the presence of OSAS is clinically important, such as when using anesthesia and by non-anesthesiologists performing invasive tests under sedation [6,7], which is especially important in this clinical context since it would not be feasible to send every patient for polysomnography before sedation/anesthesia. Our sensitivity and specificity results are broadly consistent with a recent review article of the DES-OSA score and outperform other scoring systems [7]. From this perspective, the present study acts as an external validation and confirmation of the DES-OSA score.

The limitations in our research include possible discrepancies in the medical history records of the patients. DTC values increased as the severity of the OSAS increased, while in the original study this criterion showed a decreasing trend as the severity level rose for unknown reasons [6]. Our patients had already been pre-selected by their referring physician for polysomnography. We cannot assume the same levels of Sn/Sp in the general population. However, physicians in general only perform diagnostic testing in patients where a certain disease is suspected. Use of the DES-OSA to screen patients with or without clinical suspicion of OSAS seen in the community would be an interesting proposition for future research.

CONCLUSIONS

The DES-OSA and modified DES-OSA66 scores were found to be a valid method to exclude OSAS in patients but the scores did not accurately predict severity.

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Capsule

Exploiting a stress response to fight cancer

Pancreatic ductal adenocarcinoma (PDAC) is associated with extremely poor survival, and better treatments are urgently needed. **Kartha** and co-authors found that high sirtuin 6 (SIRT6) abundance defines classical PDAC and controls activating transcription factor 4 (ATF4) by regulating its stability. ATF4 is known to control the integrated stress response, which is constitutively active in classical PDAC. The more aggressive basal subtype was characterized by low SIRT6 expression, leading to low ATF4 abundance and therefore poor activation of the integrated stress response. Basal PDAC xenografts were therefore sensitive to the inhibition of two cyclin-dependent kinases, suggesting a potential treatment avenue for this extremely aggressive cancer subtype.

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