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The Efficacy of the Berlin Questionnaire and the Epworth Sleepiness Scale in Obstructive Sleep Apnea

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Abstract

Background: Obstructive sleep apnea (OSA) is a disease in which apnea-hypopnea attacks occur during sleep and is characterized by a reduction in blood oxygen saturation during sleep. The gold standard diagnostic method is polysomnography (PSG).However, PSG is a time-consuming method that is expensive and requires special equipment, and care has to be taken in patient selection for PSG. The aim of this study was to evaluate the efficacy of the Epworth Sleepiness Scale (ESS) and the Berlin Questionnaire (BQ) in predicting OSA through comparisons with PSG.

Materials and Methods: A retrospective examination was made of the records of patients who underwent one night PSG between September 2022 and December 2022, and the relationship of the BQ and ESS scores with the Apnea-Hypopnea Index (AHI) value determined in PSG was evaluated.

Results: Evaluation was made of a total of 115 patients, comprising 77 (67%) males and 38 (33%) females. Ninety-nine of 115 subjects (86%) had AHI ≥ 5, and 85.5% of them were classified as being at high risk of sleep apnea with BQ and 54.9% of them were classified as having excessive daytime sleepiness with ESS. The consistency of the BQ and ESS for AHI ≥15 in OSA cases was determined to be 89.9% and 61.8%, respectively. Sensitivity of BQ (0.91) was highest when we selected the cut-off value of AHI as 30.

Conclusion: The BQ was determined to be more effective than the ESS in the prediction of OSA diagnosis both in cases with AHI ≥5 and AHI≥15.

Keywords: Berlin Questionnaire, Epworth Sleepiness Scale, Obstructive Sleep Apnea, Polysomnography

Introduction

Obstructive sleep apnea (OSA) is disease in which apnea-hypopnea attacks occur during sleep and is characterized by a reduction in blood oxygen saturation during sleep [1,2]. Frequent awakenings during sleep cause disrupted sleep, which diminishes quality of life in these patients [3]. Early and appropriate treatment of OSA can overcome the health problems that can develop in patients. Male gender, advanced age, and obesity increase the predisposition to OSA. The prevalence of OSA ranges from 1.2% and 28% depending on geographic region, ethnicity, and study methodology [4-7]. In an epidemiological study in Turkey, the risk of OSA was determined as 13.7% [8]. The gold standard diagnostic methods are polysomnography. The number of apnea-hypopnea episodes per hour is stated as the apnea-hypopnea index (AHI) values. The severity of OSA is defined as mild with<5 apnea-

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hypopnea, moderate (5≥AHI<15), severe (15≥AHI<30) and very severe (AHI≥30) [9]. Polysomonography is the gold standard method but full-night monitorisation is time-consuming, and the method is expensive and requires special equipment. Therefore, sleep disorder questionnaires can help in selection of patients for PSG. Questionnaires can be helpful for general practitioners, surgeons and sleep specialists to identify OSA in the general population, surgical patients, and sleep clinic patients. Berlin Questionnaire is one of the questionnaires described for sleep disorders. The BQ was developed to determine patients at high risk of OSA [10, 11]. Another of the scale for sleep disorders is the Epworth Sleepiness Scale (ESS), which is a self-reported evaluation of daytime excessive sleepiness [12].

Although there are reports in literature showing that the ESS and BQ can be successful in the screening of OSA [13-15], there are also publications with contrasting results and which report the need for care to be taken in the evaluation [16, 17]. The aim of this study is to compare the efficacy of the sleep questionnaires ESS and BQ, in predicting OSA.

Materials and Methods

Retrospective examination was made of the records of patient with an initial diagnosis of OSA who underwent PSG at Afyonkarahisar Health Sciences University Medical Faculty Hospital. The study includes 115 patients aged ≥18 years who underwent PSG between September 2022 and December 2022. The patients were excluded form study if they had a central sleep apnea or leg movement disorders of sleep disease. The demographic data of all participants were recorded, and the data of the ESS and BQ completed during presentation were retrieved from the patient files.

Ethics Committee Approval: The study was initiated with approval of the Afyonkarahisar Health Sciences University Medical Faculty (Date: 2022 Decision no: 2022/16-2011-KAEK-2). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

The Scales Used To Identify Obstructive Sleep Apnea: The Berlin Questionnaire was developed to screen the general population [18]. The questionnaire consists of 10 items in 3 categories: snoring behavior (category 1, items 1-5), daytime sleepiness or fatigue (category 2, items 6-9), and presence of obesity or hypertension (category 3, item 10). Patients with permanent or frequent (>3-4 times per week) symptoms in least 2 of the 3 categories are classified as at risk of developing sleep apnea. Snoring, witnessed apnea, morning headache, and increased daytime sleepiness are among the clinical symptoms of OSA [18].

The Epworth Sleepiness Scale is applied to show the daytime sleepiness status [19]. The scale consists of 8 items, each of which is completed by the patient and scored from 0-3 points. The patient is questioned about the probability of falling asleep in certain situations on a normal day when they are not excessively tired. The scoring method is the same for all the items: 0= no probability of falling asleep, 1= low probability, 2= moderate probability and 3= high probability. A total score of ≥10 points indicates the presence of a state of excessive sleepiness. Validity of the ESS in Turkish was shown in a study by Izci et al. [12].

The PSG examination was conducted with a standard PSG device (COMPUMedics ProFusion PSG3). In the standard PSG, a record was made of electroencephalogram, electrocardiogram, electro-oculogram, chin electromyogram, oro-nasal airflow, oxygen saturation with pulse oxymeter, and chest, abdomen, and leg movements. The polysomnographic recording was scored manually by the sleep specialist. Scoring was made according to the American Sleep Medicine Association guidelines [20].

The cases included in the study were categorized as simple snoring (AHI <5), mild OSA (AHI 5-15), moderate OSA (AHI 15-30), and severe OSA (AHI >30).

Statistical Analysis

Data obtained in the study were analyzed statistically using IBM SPSS statistics software. Patient age was stated as median, minimum and maximum values and all other continuous variables as mean ± standard deviation (SD) values. Categorical variables were stated as number (n) and percentage (%). The Chi-square test was used to compare rates in two groups. A value of $p<0.05$ was accepted as statistically significant. Sensitivity and accuracy of BQ and ESS were calculated from cross-tables using PSG results as gold standard. We also classified the severity of OSA based on AHI values and determined predictive accuracy of BQ and ESS in different cut-off values of AHI.

Results

Demographic data, PSG results of our study population are demonstrated in Table 1. Evaluation was made of a total of 115 patients, comprising 77 (67%) males and 38 (33%) females with a median age of 51 years (range, 20-79 years) and mean BMI of 31.9 kg/m^2. PSG study confirmed OSA diagnosis in 99 of 115 subjects (86 %) whereas 16 subjects had AHI < 5. The mean AHI value of all the study participants was 34.9, with 13.9% of cases evaluated as simple snoring, 25.2 % as mild OSA, 17.4 % as moderate OSA, and 43.5 % as severe OSA.

In our study, we divided subjects into two groups according to risk categorization as high-risk group (AHI ≥15 (n = 70) and low-risk group AHI <15 ((n=45). We compared parameters between low-risk and high-risk subjects (Table 2). Age, body mass index, AHI of two groups were different ($P < 0.005$) (Table 2). The moderate-severe OSA group

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determined with AHI ≥15 had a median age of 54 years and mean BMI of 33.2 kg/m^2. In the mild OSA and simple snoring group, the median age was 45.8 years and mean BMI was 29.7 kg/m^2. The median age and BMI were higher in patients with AHI ≥15 than in the patients with AHI <15.

The sensitivity of BQ was 85.5% in cases with AHI ≥5. The agreement of the ESS evaluation with PSG was determined to be 32.6% in cases with AHI ≥5. The sensitivity/ specificity of BQ and ESS were shown Table 3. In the high-risk cases with AHI ≥15, the agreement of the BQ and ESS evaluations with PSG was determined to be 89.9% and 61.8%, respectively. The specificity of BQ for patients with AHI of ≥5, 46.5% and AHI of ≥15 41.5%. Sensitivity of BQ (91.4%) was high when we selected the cutoff value of AHI as 30. The specificity of BQ (37.5%) was when we selected the cutoff value of AHI as 30 (Table 4).

Table 1: Demographic data of study population

Gender	n:115	%
Male	77	67
Famale	38	33
Age (years) (min-max)	51 (20-79)	
BMI (kg/ m2)	31.9	
AHI < 5	16	13.9
5 ≤ AHI < 15	29	25.2
15 ≤ AHI ≤ 30	20	17.4
AHI > 30	50	43.5
AHI(mean±sd)	34.9 ± 2.8	

Table 2: Demographic data, polysomnographic results and subjects with low risk(AHI <15) and high risk(AHI ≥15) for sleep apnea.

Parameters	Low risk(n:45)	High risk(n:70)	P value
Age (years) (min-max)	45.8	54	p<0.05
BMI (kg/ m2)	29.7	33.2	p<0.05
AHI	18	36	p<0.05

Table 3: Accuracy of risk grouping by BQ compared with polysomnography results as gold standard.

Polysomnography results	Sensitivity of BQ	Specificity of BQ
AHI ≥ 5	85.5%	46.5%
AHI ≥ 15	89.9%	41.5%
AHI ≥ 30	91.4%	37.5%

Table 4: Accuracy of risk grouping by ESS compared with polysomnography results as gold standard.

Polysomnography results	Sensitivity of ESS	Specificity of ESS
AHI ≥ 5	32.6%	59%
AHI ≥ 15	61.8%	62.1%
AHI ≥ 30	65.6%	57.2%

Discussion

Through examinations of the relationships of the ESS and BQ completed during presentation with the AHI value determined as a result of PSG, the efficacy of these questionnaires in the prediction of OSA was evaluated. Of the patients included in this study, 67% were male. Previous population-based studies have determined the prevalence of OSA to be approximately 11% in males and 4% in females [21]. In a study that examined the effect of gender on symptoms, it was seen that females had fewer complaints of typical OSA symptoms (snoring, apnea) and there was a greater probability of reporting symptoms of fatigue, morning headache, and lack of sleep [22]. The ratio of male to female patients in the current study was 2:3. The frequency of OSA increases with age and it is thought that the anatomic changes in the upper respiratory tract that occur together with ageing increase the prevalence of OSA in elderly patients [23]. Similarly, the median age of the cases in the current study was determined to be high (51 years). An increase in BMI is an important independent risk factor increasing the tendency for OSA [24]. The mean BMI in the current study was high at 31.9 kg/m^2.

Questionnaires have been developed which can help in the selection of appropriate patients for PSG testing when OSA is suspected. In the literature, varied sensitivity results of BQ have been reported in different study populations. The BQ evaluation separates cases into categories of low-risk and high-risk for OSA. In the study by Kang et al. sensitivity of Korean version of BQ was found as 69% when cut-off value of AHI was set at 5 in the general population [25]. Saleh et al. found the high sensitivity and specificity of BQ in the literature as 97% and 90% respectively at a cut-off value of AHI ≥ 5 in 100 sleep clinic patients [26]. Sagaspe et al. determined sensitivity and specificity of BQ as 72% and 73% at a cut-off value of AHI > 5 [27]. Another study determined the efficacy of BQ to be 84.2% in cases with AHI ≥15 [28]. In a meta-analysis of 26 studies, it was reported that of non-PSG screening tools, BQ had a high diagnostic probability rate [29]. The results of this study showed BQ agreement with PSG of 85% for patients with AHI of ≥5, and 89% for cases with AHI ≥15. The specificity of BQ for patients with AHI of ≥5 46.5%.When we evaluated the sensitivity of BQ at different cut-off values, we determined the sensitivity of BQ as 91.4% at a cut-off value of AHI > 30 and as 89.9% at a cut-off value of AHI ≥ 15. Similar to the result of study by Kang et al., sensitivity of BQ such as 89% at a cut-off value of AHI ≥ 15. However, these studies did not evaluate sensitivity and specificity of BQ at a cut-off value of AHI > 30. Suskaron et al. Determined sensitivity and specificity of BQ at a cut-off value of AHI > 30 96.2% and 43,8% respectively [30]. In a meta-analysis of 42 studies for BQ, it was reported that for moderate OSA, the pooled sensitivity levels were 77%, pooled specificity levels were 44%, for severe OSA, the

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pooled sensitivity levels were 84%, pooled specificity levels were 38% [31].

The ESS is an evaluation that is focused on determining increased daytime sleepiness, and a score of ≥10 points indicates increased daytime sleepiness. In a study that evaluated 2112 cases, the efficacy of the ESS in OSA screening was reported to be 54% in cases with AHI ≥15 [32]. In that study, although the ESS was good for the determination of daytime sleepiness, it was seen to be affected by gender, ethnicity, and body fat distribution differences, and thus it was reported that it was insufficient to be used as a screening tool in the determination of OSA. Similar to these findings in literature, the ESS was found to be effective at the rate of 61.8% in the current study cases with AHI ≥15. A meta-analysis which evaluated 42 studies for BQ and 15 studies for ESS reported the efficacy of the BQ and ESS to be 76% and 54% respectively in the mild OSA group, 77% and 57% in the moderate OSA group, and 84% and 58% in the severe OSA group [31]. A previous study in Turkey emphasized that the BQ evaluation was more effective than ESS in the moderate-severe OSA group [33]. The different focus of questionnaire items has an effect on the different efficacy of questionnaires that can be used to identify OSA. However, many sleep disorders other than OSA can lead to daytime sleepiness. Therefore, the ESS may be insufficient to determine cases at high risk of OSA [34].

This study had some limitations primarily that it was retrospective in design and was conducted in a single center. Participants with comorbidities were not excluded from the study but it was not a complete sample of the general population. A further limitation could be said to be that no evaluation was made with the STOP-BANG questionnaire, as higher rates of agreement could have been determined with this questionnaire compared to the others.

Conclusion

In conclusion, the results of this study demonstrated that the BQ and ESS could correctly classify sleep clinic patients in respect of predicting OSA with efficacy of 85.6% and 59.4%, respectively, in cases with AHI value >5, and efficacy of 89.9% and 61.8%, respectively, in moderate-severe OSA cases. In both groups the efficacy of the BQ in determining a diagnosis of OSA was determined to be higher.

Ethical Declarations

Ethics Committee Approval: The study was carried out with the permission of Afyonkarahisar Health Sciences University University/Training and Research Hospital, Noninvasive Clinical Ethics Committee (Decision No: 2020/16)

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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