JOURNAL OF HEALTHCARE SCIENCES
Volume 1 Issue 6 2021, Article ID: JOHS2021000309
http://dx.doi.org/10.52533/JOHS.2021.1506

Review

Obstructive Sleep Apnea Screening Tools Effectiveness and Its Use in Primary Care

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Received: 8 September 2021, Revised: 14 September 2021, Accepted: 17 September 2021, Published: 20 September 2021

Abstract

To diagnose obstructive sleep apnea, polysomnography has been widely used as the gold standard diagnostic modality to successfully achieve this purpose. However, the modality has been reported to be time-consuming and costly, and therefore, other substitutes have been reported in the literature as valid tools that are also cost-effective, and can successfully replace polysomnography. The highest sensitivity rates were associated with the STOP-BANG questionnaire for detecting mild and severe cases with obstructive sleep apnea. However, the highest sensitivity was associated with the Berlin questionnaire for detecting both degrees of obstructive sleep apnea. For moderate cases, the highest specificity and sensitivity rates were reported with the STOP questionnaire. However, it should be noted that there are huge variations between the different studies in the literature, and therefore, further studies with a better definition of hypopnea and valid comparative findings of the different tools are urgently needed, and until then, the current findings should be interpreted with caution.

Keywords: obstructive sleep apnea, screening, sensitivity, validation, questionnaire.

Introduction

Estimates from the United States demonstrate that among middle-aged individuals, obstructive sleep apnea is a common condition (1). Further estimates also show that the prevalence of the condition has recently increased from 14-55% as a result of the increasing prevalence of obesity, which is considered a major risk factor for developing obstructive sleep apnea (**Figure 1**) (2).

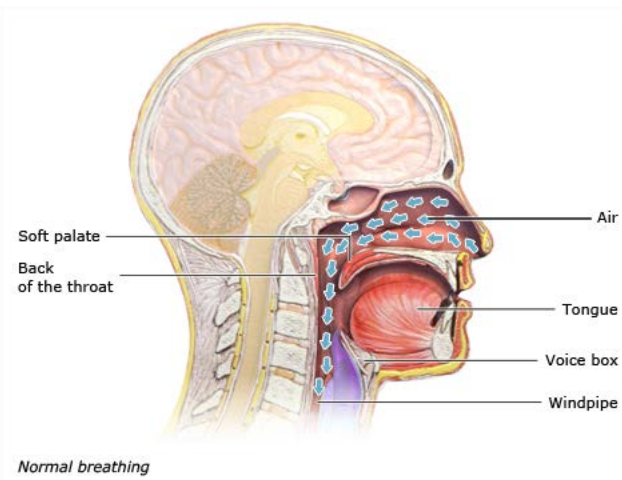

Figure 1. Pathology of obstructive sleep apnea (3).

Although the condition has been widely recognized, it has been demonstrated that a large proportion of patients (possibly up to 80%) are still undiagnosed (4). The effect of undiagnosed cases with obstructive sleep apnea constitutes a significant problem as it has been estimated to burden the healthcare systems of the United States with a total cost of $149.6 billion per year (4). To diagnose obstructive sleep apnea, polysomnography has been widely used as the gold standard in diagnostic modality to successfully achieve this purpose (5). However, the modality has been reported to be time-consuming and costly, and therefore, other substitutes have been reported in the literature as being valid tools that are also cost-effective, and can successfully replace polysomnography (6, 7). Many questionnaires have been utilized in the literature, including up to 10 tools that have been validated by different investigations (8). However, not all of them are widely used or validated, and only a few have been widely used in the literature. We aim to provide evidence regarding the effectiveness and clinical uses of the most common screening tools that have been validated to detect obstructive sleep apnea among the different studies in the literature.

Review

Many studies have been published to validate these scores by estimating the sensitivity, specificity, and positive and negative predictive values. In general, the severity of the condition was investigated and reported using the respiratory disturbance index, and apnea-hypopnea scale, based on which mild, moderate, and severe cases were diagnosed at cutoff points of ≥ 5, 15, and 30 events/hour, respectively. We will discuss the questionnaires that have been reported as low-cost substitutes to the overnight laboratory polysomnography, which is not cost-effective and may be difficult to apply.

The first tool discussed is the STOP-BANG questionnaire, which is formed of four subjective, and another four demographic items, including the BANG (BMI, Age, Neck circumference, Gender), and STOP (Snoring, tiredness, observed apnea, and high blood pressure) items. It has been demonstrated that those at a high risk of having obstructive sleep apnea have a score of 5-8 (9, 10). Many studies in the literature were published to validate the effectiveness of this score, and most of them include sleep clinic participants. Additionally, many studies in the literature used overnight laboratory polysomnography as their validation tool for the included patients in their investigations. It has been reported that the STOP-BANG questionnaire has been associated with the highest specificity in the assessment and diagnosis of moderate obstructive sleep apnea, with a rate of 74.7%. Additionally, among the different studies, the positive predictive value at apnea-hypopnea cutoff ≥ 5 events/hour was hugely variable, with estimated rates that ranged between 12.2% and 93.7% (11). The positive predictive value was also hugely variable at a cutoff point of 30 events/hour, and El-Sayed et al. (12) reported a high value of 73.37%, as one of the highest among the different studies in the literature.

At apnea-hypopnea cutoff point of 30 events/hour, most of the included studies reported high sensitivity rates. For instance, El-Sayed et al. (12) reported that the estimated sensitivity at this cutoff was 98.65%. It should also be noted that the authors estimated high sensitivity rates for the tool at ≥ 5, and 15 events/hour cutoff points, being 97.55%, and 97.74%, respectively. In another investigation, Pataka et al. (13) also estimated the sensitivity rate to be 98.7%, 94%, and 90% at the following cutoff points of 30, 15, and 5 events/hour respectively. However, it should be noted that not all of the included studies estimated high sensitivity rates

http://dx.doi.org/10.52533/JOHS.2021.1506

and among them, some studies reported very low rates as compared to the aforementioned investigations. For instance, Silva et al. (14) reported that the estimated sensitivity rate at apnea-hypopnea cutoff point of 30 events/hour was 70.4%, which was associated with a specificity rate of 59.5% only. Additionally, the authors reported that the sensitivity and specificity for the tool at apnea-hypopnea cutoff point of 15 events/hour was 87%, and 43.3%, respectively. A further investigation by Tan et al. (15) also reported that the sensitivity rate at apnea-hypopnea cutoff ≥ 30 events/hour was 69.2%, and the specificity was 67.1%. Similar sensitivity (66.2%) and specificity (74.4%) rates were also reported at a cutoff point of 15 events/hour. It should be noted that the positive predictive values among these studies were found to be very low, while the negative predictive value was much higher.

Another screening tool that was also reported with high sensitivity rates is the STOP questionnaire. It has been previously reported that a diagnosis of severe obstructive sleep apnea can be adequately established using the STOP questionnaire if the patient answers at least two of the tool's items with yes (10). Most of the included studies included sleep clinic patients, while some studies included bus drivers, surgical patients, and a community population (14, 16-18). Overnight laboratory polysomnography was used by most studies to compare the validity of the screening tools, while only a few used daytime and type II polysomnography (14, 17). In cases of moderate obstructive sleep apnea, it has been previously demonstrated that the tool has the highest specificity, sensitivity, and negative predictive value, which were 92.3%, 100%, and 100%, respectively. On the other hand, it should be noted that the positive predictive value was hugely variable among mild cases, with estimated values of 12.8-92.5% among the different studies (11). In an investigation by Firat et al. (17), they estimated specificity, sensitivity, positive, and negative predictive values of 92.3%, 41.3%, 86.4%, and 57.1%, respectively for the STOP questionnaire ability to assess moderate obstructive sleep apnea. In another investigation, Ha et al. (19) assessed the effectiveness of the tool in detecting the different degrees of sleep apnea. They reported that the highest sensitivity of the tool was estimated for moderate apnea (76.19%), while mild apnea was also found to have the highest positive predictive value (85.57%). However, Sadeghniiat-Haghighi et al. (20) reported that the highest sensitivity rate for the tool was found when assessing for severe cases of obstructive sleep apnea (94.1%), which was also associated with a high negative predictive value (91.1%), however, the estimated specificity and positive predictive values were very low (30.7%, and 40.2%, respectively). Other investigations also reported high sensitivity rates for the different degrees of sleep apnea based on the apnea-hypopnea index cutoff (16, 21). Therefore, careful interpretation of these variable findings is recommended until further validation by other investigations is achieved.

The Berlin questionnaire has also been widely used among various studies since it was first published in 1999. The questionnaire is mainly formed of three sections, including snoring, daytime sleepiness and fatigue, and medical history of the patient together with a brief assessment of any associated morbidities as hypertension, in addition to the body mass index. A high risk of developing obstructive sleep apnea was established when the patient was reported positive in different categories (22). Similar to the studies that assessed the previous tools, most patients within the included studies were assessed in sleep clinics, while only a few studies investigated the validity of the tool in the general population (23, 24), and some studies included mixed types of populations in their studies. Most studies also reported using the overnight polysomnography for validation, while some studies reported using the type I and II polysomnography (24-28). Type II polysomnography is similar to the standard test but is done at a full in-home pattern. Type III polysomnography assesses several physiological variables, including a cardiac variable, two respiratory variables, daytime polysomnography, and arterial oxyhemoglobin saturation (17). For assessment of severe obstructive sleep apnea, the highest sensitivity rate was reported by El-Sayed et al. (12), at 97.3%, while the estimated specificity was only 10.71%. The same authors also reported the highest sensitivity rate among the different studies in the literature for assessment of moderate obstructive sleep apnea (95.48%), however, the specificity rate was also very low (7.41%), with a positive predictive value of 87.11%. Similar findings were also reported for detection of mild cases, with a positive predictive value of 92.79%. Similar findings were also reported by Pereira et al. (29), which reported that the sensitivity of the Berlin questionnaire was 86%, 91%, and 89% for assessment of mild, moderate, and severe cases, respectively. Similar findings were also reported by other investigations, which indicated the high sensitivity of the tool in detecting the different degrees of apnea, however, the specificity rates were also reported to

http://dx.doi.org/10.52533/JOHS.2021.1506

be markedly low (13, 19, 30-34). On the other hand, other investigations reported higher specificity rates and lower sensitivity rates, with high negative and low positive predictive values. For instance, a previous investigation by Best et al. (25) reported that to detect moderate cases, the Berlin questionnaire was associated with a sensitivity rate of 24.5% only, however, the estimated specificity was very high (91.7%), with a negative predictive value of 93.3%. Faria et al. (35) reported that the estimated specificity rate was as high as 68.4%, with a positive predictive value of 25%, a negative predictive value of 81.2%, and a low sensitivity rate of 40% for assessment of mild cases. Finally, the lowest positive predictive value was 1.11%, which was estimated by Kicinski et al. (36) for moderate cases, with sensitivity, and specificity rates of 93.1%, and 16.2%, respectively. The positive predictive values of the Berlin questionnaire seem to be very low for the different degrees of sleep apnea. On the other hand, higher positive predictive values for detecting mild cases were reported to be around 97% in many investigations (5, 31, 37). In a previous meta-analysis, the authors reported that the Berlin questionnaire had moderate specificity and sensitivity results in detecting cases of hypopnea with 3% O_2 desaturation, however, it was also reported that the estimated rates significantly reduced when hypopnea was defined as having 4% O_2 desaturation (38). Accordingly, it has been demonstrated that a clear and standarized definition of hypopnea should be established for adequate validation of the used tools, which may also explain the huge variations of findings among the different studies.

Another common scale that has been reported by many investigations is the Epworth sleepiness scale, which has been used to assess daytime sleepiness. The score of this tool ranges between 0 and 24, and a high risk of obstructive sleep apnea is detected by a ≥ 11 score, which also indicates the presence of excessive daytime sleepiness (39). Sleep clinic patients were the most frequently included among the different investigations in the literature, and some studies included clinic outpatients, respiratory patients, and individuals from the general population (14, 35, 40). Additionally, most studies used laboratory polysomnography for validation of the tool. For mild sleep apnea, the highest sensitivity was reported in the study by El-Sayed et al. (12) at 72.55%, which was associated with a high positive predictive value of 96.73%. For severe sleep apnea, different studies indicated that the sensitivity rates were variable among them and ranged between 46.1%, and 79.73% (11). The sensitivity rates were also low among the different studies for moderate cases with obstructive sleep apnea, except for the study by El-Sayed et al. (12), which estimated a rate of 75.71%. In a previous systematic review, Amra et al. (11) reported that the highest positive and negative predictive values and specificity rates were noticed among mild cases, being 96.7%, 87.5%, and 75% among 11 investigations that studied the validity of the Epworth sleepiness scale for detection of obstructive sleep apnea. Additionally, it has also been reported that a decreasing pattern of the aforementioned values was noticed from mild to severe cases (11).

Conclusion

The highest sensitivity rates were associated with the STOP-BANG questionnaire for detecting mild and severe cases with obstructive sleep apnea. However, the highest sensitivity was associated with the Berlin questionnaire when detecting both degrees of obstructive sleep apnea. For moderate cases, the highest specificity and sensitivity rates were reported with the STOP questionnaire. However, it should be noted that there are huge variations between the different studies in the literature, and therefore, further studies with a better definition of hypopnea and valid comparative findings of the different tools are urgently needed, and until then, the current findings should be interpreted with caution.

Disclosure

Statement:

The authors declare no conflict of interest.

Funding:

None

Ethical Consideration:

Non applicable.

Data Availability:

All data are presented within the paper.

Author Contribution:

All authors equally contributed in conceptualizing, drafting, searching the literature, writing, language editing and proofreading the manuscript.

http://dx.doi.org/10.52533/JOHS.2021.1506

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