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Screening Questionnaires for Obstructive Sleep Apnea: An Updated Systematic Review

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Abstract

Background: *Obstructive sleep apnea (OSA) is the most common sleep-related breathing disorder, which is associated with significant morbidity. The aim of the current study was to do an updated systematic review of literature on studies assessed the accuracy of screening questionnaires for OSA against polysomnography (PSG) as the reference test.*

Methods: *An English literature search was performed using Medline, Cochrane Database of Systematic Reviews and Scopus between January 2010 until April 2017. The reference list of included studies were also manually searched for finding additional studies.*

Results: *Thirty-nine studies comprising 18068 subjects included in the systematic review. The sensitivity of STOP-Bang questionnaire (SBQ) in detecting mild (AHI≥5 events/h) and severe (AHI≥30 events/h) OSA was higher in comparison to other screening questionnaires (ranged from 81.08% to 97.55% and 69.2% to 98.7% respectively). However, STOP questionnaire (SQ) had the highest sensitivity in prediction of moderate OSA (AHI≥15 events/h) (ranged from 41.3% to 100%).*

Conclusion: *The results of the present systematic review suggested SQ and SBQ for screening of OSA among sleep clinic patients. Although further validation studies of screening questionnaires on general populations are required.*

Keywords: Obstructive Sleep Apnea, Screen, Validation, Sensitivity, Specificity

Introduction

Obstructive sleep apnea (OSA) is the most common sleep breathing disorder, which is manifested by repeated apneas and hypopneas during sleep [1-3]. OSA increases the risk of some medical conditions such as hypertension, glucose intolerance, cardiovascular and cerebrovascular disorders [4-7]. Daytime sleepiness, cognitive dysfunction and increased risk of automobile accidents are also associated with untreated OSA [8-10].

Polysomnography (PSG) is the gold standard for diagnosis of OSA, which is an expensive and time-consuming procedure. Therefore, different clinical models have developed to evaluate the patients at high risk for OSA [11, 12]. Screening questionnaires are simple and low-cost tools that can prioritize patients for PSG.

The screening questionnaires for OSA identification have been reviewed in a systematic review by Abrishami et al. They suggested STOP and STOP-Bang questionnaires for screening of OSA in surgical population regarding their higher methodological quality and easy-to-use characteristics [13]. Over the past few years, accuracy of screening questionnaires for OSA has been an area of growing research interest and many studies have been published since the publication of the current systematic review. The aim of the present systematic review was to assess the accuracy of OSA screening questionnaires based on an updated review literature.

Methods

Literature search

A literature search was performed using Medline, Cochrane Database of Systematic Reviews and Scopus between January 2010 until April 2017. The search strategy consisted of the following terms: OSA or OSAHS, hypopnea or hypopnoea, obstructive sleep apnea

or obstructive sleep apnoea, sleep apnea syndrome and sensitivity or specificity or validity or validation, sleep apnea questionnaires, screening sleep apnea. The reference list of identified studies was also searched manually to detect eligible studies for inclusion in the review. The flow diagram of study selsction was shown in (Table 1).

Table 1: Overview of studies induded looking at the accuracy of screening questionnaires for obstructive sleep apnea against polysomnography (PSG) as the reference test

Study	No of patients	Patient type	Age, years	Male, 96	Body mass index, kg/ml	Validation tool
Ong et al. 2010[36]	314	Sleep clinic patients	46.8 ± 15	70.5	27.9 ± 6	Lab PSG
Sagaspc et al. 2010[43]	123	Sleep clinic patients	47 ± 13.2	67.5	-	Lab PSG
Gantner et al. 2010[25]	143	Patients with high cardiovascular risk	62.2 ± 7.6	58	26.6 ± 3.7	Level II PSG
Silva et al. 2011[47]	4770	General population	62.4 ± 10.3	51.5	-	Level II PSG
Saleh et al. 2011[44]	100	Sleep clinic patients	45.63 ± 9.67	51	36.34 ± 10.70	Lab PSG
Srijithesh et al. 2011[48]	121	Acute stroke patients	56.5		-	Lab PSG
Sforza et al. 2011[46]	643	General population	65.6 ± 0.03	40.90	25.3 ± 0.2	Level III PSG
Enciso et al. 2011[22]	84	Dental clinic patients	54.93 ± 12.63	77.38	26.60 ± 3.74	Two night ambulatory somnography
Thurtell et al. 2011[30]	30	Patients with idiopathic intracranial hypertension	32 ± 6.3	20	24.4 ± 4.1	Lab PSG
Martinez er al. 2012[34]	57	Patients with angina complaints	54 ± 6.9	46	23 ± 11	Level III PSG
Hessclbacher et al. 2012[27]	1897	Sleep clinic patients	53.84 ± 15	57.56	35.42 ± 5	Lab PSG
El-Seyed et al. 2012[21]	234	Sleep clinic patients	50.38 ± 11.29	58.5	37.77 ± 9.54	Lab PSG
Hessclbacher et al. 201227	1897	Sleep clinic patients	53.84 ± 15	57.56	35.42 ± 5	Lab PSG
El-Seyed et al. 2012[21]	234	Sleep clinic patients	50.38 ± 11.29	58.5	37.77 ± 9.54	Lab PSG
Firat et al. 2012[24]	85	Bus drivers	-	100	29.1 ± 3.8	Daytime PSG
Amra et al. 2013[11]	157	Sleep clinic patients	52.3 ± 13.6	55.4	31.5 ± 6	Lab PSG
Bouloukaki et al. 201319	189	Clinic outpatients	47 ± 13	61.9	35.0 ± 25.1	Lab PSG
Kang et al. 2013[17]	1305	General population	52.78 ± 16.55	47.7	22.81 ± 4.86	Lab PSG
Best et al. 2013[17]	82	Patients with treatment resistant depression	47.1 ± 9	26.83	33.34 ± 8.6	Level II PSG
Yunus et al. 2013[34]	150	Clinic outpatients	44.7 ± 11.5	64	36.3 ± 11.2	Lab PSG
Boynton et al. 2013'"	219	Sleep clinic patients	46.3 ± 13.9	44.8	33.43 ± 8.76	Lab PSG
Pereira et al. 2013[38]	128	Sleep clinic patients	50 ± 12.3	65.62	31 ± 6.6	Lab PSG
Scarlata et al. 2013[45]	254	Clinic outpatients	65.8 ± 12.1	68.6	38.5 ± 7.7	Lab PSG
Vana et al. 2013[52]	47	Sleep clinic patients	46.4 ± 13.2	34	36.3 ± 9.2	Lab PSG
Pataka et al. 2014[37]	1853	Sleep clinic patients	52 ± 14	74.42	32.8 ± 7	Lab PSG
Karakoc et al. 2014[29]	217	Surgical population	42.5 ± 10.7	88	28.10 ± 4.1	Lab PSG
Margallo er al. 2014[33]	422	Patients with resistant hypertension	62.4 ± 9.9	31	31.2 ± 5.7	Lab PSG
Ha et al. 2014[26]	141	Sleep clinic patients	44.82 ± 12	81.6	25.33 ± 5	Lab PSG
Ulasli et al. 2014[51]	1450	Sleep clinic patients	50 ± 9.83	62.96	31.25 ± 9.09	Lab PSG
Kim et al. 2015[32]	592	Sleep clinic patients	47.8 ± 12.7	83.5	24.7 ± 3.5	Lab PSG
Alhouqani et al. 2015[16]	193	Sleep clinic patients	42.87 ± 11.83	77.7	34.90 ± 8.60	Lab PSG
Sadeghniiat Haghighi et al. 2015[42]	603	Sleep clinic patients	45.8 ± 12.7	74.8	29.18 ± 5.9	Lab PSG
Yuceege et al. 2015[53]	433	Sleep clinic patients	47.5 ± 10.5	65.82	31.1 ± 5.6	Lab PSG

Nunes et al. 2015[35]	40	Coronary artery bypass grafting patients	56 ± 7	73	30 ± 4	Lab PSG
Nunes et al. 2015[35]	41	Abdominal surgery patients	56 ± 8	68	29 ± 5	Lab PSG
Faria et al. 2015[23]	91	Patients with chronic obstructive pulmonary disease	69.4 ± 9.6	63.7	23.6 ± 3.9	Lab PSG
Popevic et al. 2016[39]	100	Commercial drivers	43.4± 10.7	100	29.0 ± 5.7	Lab PSG
Khaledi-Paveh et al. 2016[39]	100	Sleep clinic patients	45.66 ± 11.83	60	29.5 ± 6.1	Lab PSG
Kicinski et al. 2016[31]	123	Sleep clinic patients	54.6 ± 11.1	66.40	33.5 ± 5.2	Lab PSG
Tan et al. 2016[49]	242	General population	48.3 ± 14	50.4	26.2 ± 5	Level 3 PSG
Bhat et al. 201[18]	85	Sleep clinic patients	50.5 ± 12.6	70.6	32 ± 1.55	Lab PSG/ Level III PSG
Prasad et al. 2017[°]	210	Sleep clinic patients	46.5 ± 13.7	72.9	31.9 ± 7.4	Lab PSG

Eligibility criteria and data extraction

Two authors independently reviewed titles and abstracts of the searching results and disagreements were solved with group discussion. The studies had to meet the following requirements to be included in the systematic review: a) involved participants aged >18 years b) the accuracy of screening questionnaire was assessed against various apnea-hypopnea indexes (AHI) or respiratory disturbance indexes (RDI) based on PSG as the gold standard c) studies were published in English. We also included studies if the validity of screening questionnaires was reported in them as secondary outcome. Letters to the Editor, review articles, case-reports, and commentaries were excluded.

Two independent reviewers extracted data from each included study containing, the first author, country and year of publication, study design, number of participants, age, gender, body mass index (BMI), neck circumference, validation tool (various types of PSG including), sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for each AHI or RDI cut-off point including, AHI or RDI of ≥5 events/h (mild OSA), ≥15 events/h (moderate OSA) and ≥30 events/h (severe OSA).

Results

We included 39 studies in the present review, with the overall sample size ranged from 30 to 4770 [14-20]. Selected studies were carried on seven different geographic regions including, North America, West Asia, East Asia, Europe, South Asia, North Africa, and South America [21-44]. Included studies comprising four validated questionnaires for OSA including, Berlin questionnaire (BQ), STOP-Bang questionnaire (SBQ), Stop questionnaire (SQ) and Epworth sleeping scale (ESS). We will present our results on these screening tools separately [45-53].

Berlin questionnaire (BQ)

Twenty-nine eligible studies comprising 9444 subjects were included for the berlin questionnaire (BQ). The characteristics and demographic information of the selected studies are presented in (Table 2). The number of participants in more than 50% of studies was less than 150 and the mean age ranged from 32 to 69.4 years. We only found two studies which had been assessed the accuracy of the questionnaire among general population, while most of validation studies had been done on sleep clinic patients (n=13) [19, 29]. Over-nigh polysomnography selected as validation tool for more than two-third of selected studies (n=23). However, the instrument in seven other studies were validated by level II PSG, level III PSG, daytime PSG, and two-night ambulatory sonography [15-29].

Table 2: Predictive Parameters of the Screening Questionnaires

Study	AHI ≥ 5				AHI ≥ 15				AH1 ≥ 30			
	Sensitivity	Specificity	PPV	NPV	Sensitivity	Specificity	PPV	NPV	Sensitivity	Specificity	PPV	NPV
	%	%	%	%	%	%	%	%	%	%	%	%
Berlin												
Sagaspe et al. 201043	72	73	63		76	61	43		71	53	16	
Gamer et al. 201025	-	-	-	-	89	35	76	58	92	26	49	81
Saleh et al. 201144	97	90	96	93	-	-	-	-	-	-	-	-
Srijithcsh et al. 201148	68.2	58.8	68.2	58.8	-	-	-	-	-	-	-	-
Sforza et al. 201146	-	-	-	-	76.69	39.34	63.17	55.44	-	-	-	-
Enciso et al. 201122	-	-	-	-	67.9	54.8	72	50	-	-	-	-
Thurtell et al. 201150	83.3	58.3	75	70	-	-	-	-	-	-	-	-
Martinez et al. 201234	-	-	-	-	72	50	53	70	-	-	-	-
El-Seyed et al. 201221	95.07	25	92.79	33.33	95.48	7.41	87.11	20	97.3	10.71	74.23	60
Firat et al. 201224	-	-	-	-	45.6	84.6	77.1	56.8	-	-	-	-
Amra et al. 201311	84.0	61.5	96.0	25.8	87.9	36.7	75.3	58.0	87.8	26.5	51.5	70.9
Bouloukaki et al. 201319	76	40	94	12	84	61	86	52	79	39	80	36
Kang et al. 201328	69	83	-	-	89	63	-	-	-	-	-	-
Best et al. 201317	25.0	85.4	56.5	60.0	24.5	91.7	35.5	93.3	-	-	-	-
Yunus et al. 201354	92	17	97	29	-	-	-	-	-	-	-	-
Pereira et al. 201338	86	25	91.7	15.8	91	28	73.4	57.9	89	18	45.9	68.4
Pataka et al. 201437	71.8	17.2	11.5	80.2	78	18	16.5	80.4	90	28.5	56	74
Karakoc et al. 201429	83.4	22.2	76.4	30.8	89.3	22.6	42.1	76.9	-	-	-	-
Margallo et al. 201433	68	46	85	24	69	40	58	50	76	40	39	77
Ha et al. 201426	75	30.29	83.17	28.21	75	32.14	62.38	46.15	80.39	32.58	40.59	74.36
Ulasli et al. 201451	73.1	44.5	-	-	76.4	39.5	-	-	80.3	35.3	-	-
Kim et al. 201532	71.5	32.0	84.3	18.0	75.5	35.4	62.1	50.6	-	-	-	-
Yuceege et al. 201553	-	-	-	-	84.2	31.7	48.7	63.4	-	-	-	-
Nunes et al. 201535	-	-	-	-	67	26	50	42	-	-	-	-
Nunes et al. 201535	-	-	-	-	82	62	61	83	-	-	-	-
Faria et al. 201523	40	68.4	25	81.2	-	-	-	-	-	-	-	-
Popevic et al. 201639	50.9	86.0	82.9	56.9	78.3	77.9	51.4	92.3	75	70.4	25.7	95.4
Prasad et al. 201742	87.8	43.5	84.7	50	91.9	39.2	73.5	72.5	95.2	33	58.2	87.5
Epworth Sleepiness Scale												
Silva et al. 201147	-	-	-	-	39	71.4	-	-	46.1	70.4	-	-
Hesselbacher et al. 201227	-	-	-	-	54	57	64	47	-	-	-	-
EI-Seyed et al. 201221	72.55	75	96.73	21.13	75.71	48.15	90.54	23.23	79.73	46.43	79.73	46.43
Scarlata et al. 201345	-	-	-	-	-	-	-	-	-	-	-	-
Vana et al. 201352	31.3	53.3	58.8	26.7	-	-	-	-	-	-	-	-
Pataka et al. 201437	33.3	50.6	9.1	83.6	44.5	52.1	17	81	57	62.4	59	60
Ulasli et al. 201451	46.9	60	-	-	49.9	61.1	-	-	52.8	58.2	-	-
Faria et al. 201523	60	73.7	37.5	87.5	-	-	-	-	-	-	-	-
Kicinski et al, 201631	-	-	-	-	53.20	58.80	1.90	79	-	-	-	-
Bhat et al. 201618	-	-	-	-	46.2	65.2	75	34.9	-	-	-	-
Prasad et al. 201740	55.5	67.4	85.9	29.8	59.6	66.2	76.4	47.1	66.4	65.1	65.1	66.4

AHI: apnen-hypopnea index; **PPV:** positive predictive value; **NPV:** negative predictive value.

As shown in table 2 the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the BQ for one or more AHI cutoff points have been reported in the included studies. The highest sensitivity (97.3%) and NPV (95.4%) of the BQ for detection of OSA was found at AHI cutoffs ≥30 events/h. However, the questionnaire had the highest specificity in detection of moderate OSA (91. 7%). Our findings showed that the PPV ranged from 11.5% to 91% at AHI ≥5 events/h.

STOP-Bang questionnaire (SBQ)

For STOP-Bang questionnaire (SBQ), we included 13 studies with the total number of 9584 subjects. Majority of selected studies were large in sample size (ranged from 85 to 4770) and conducted on sleep clinic patients (Table 1). The mean age ranged from 42.8 to 62.4 years. The SBQ had been validated by overnight-laboratory polysomnography in most of selected studies except for three [22, 26, 50]. The highest sensitivity and NPV of the SBQ were reported at AHI thresholds of ≥30 events/h. The PPV value ranged between 12.2% and 93.7% at AHI cutoffs ≥5. The instrument showed the highest specificity (74.7%) in detecting moderate OSA.

STOP questionnaire (SQ)

Nine articles were included for the stop questionnaire (SQ) out of which six studies carried out on sleep clinic patients and three on community population, surgical patients, and bus drivers [22, 46]. The total number of subjects in the included studies was 8196 (ranged from 40 to 4770) and their age varied between 44.8 and 62.4 years [26]. Two studies used type 2 and daytime PSG for validation purposes, while others used overnight laboratory PSG (Table 1).

The results of the present systematic review indicated that the SQ had the highest sensitivity (100%), specificity (92.3%) and NPV (100%) in predicting moderate OSA. Our results also indicated that the PPV ranged from 12.8% to 92.5% for mild OSA (Table2).

The results of the present systematic review indicated that the SQ had the highest sensitivity (100%), specificity (92.3%) and NPV (100%) in predicting moderate OSA. Our results also indicated that the PPV ranged from 12.8% to 92.5% for mild OSA (Table2).

Epworth Sleeping Scale (ESS)

Eleven of the 40 studies investigated the accuracy of Epworth sleeping scale including a total number of 11014 subjects. The sample size in included studies ranged from 47 to 4770 and the average age ranged between 46.4 and 69.4 years. Except for three studies, which were done on respiratory patients, general population, and clinic outpatients, others conducted on sleep clinic patients. The laboratory PSG was used by the majority of the reviewed studies (Table 1) [22, 33, 46].

The sensitivity of ESS at AHI≥30 events/h ranged between 46.1% and 79.73% indicating the highest sensitivity for the questionnaire. However, the highest values of specificity (75%), NPV (87.5%) and PPV (96.7%) was found for mild OSA with a decreasing trend from mild to severe OSA (Table 2).

Discussion

It is essential to screen OSA precisely regarding its profound impact on patients' health and quality of life (53-55). It is reported that more than 80% of people with moderate to severe OSA are undiagnosed; thus, a screening tool is necessary to stratify patients based on their clinical symptoms and anthropometric risk factors [56]. Such a screening tool identifies patients at high risk for OSA and assigns therapeutic resources to them appropriately. A number of questionnaires have been developed as easy-to-use and low-cost alternatives for detecting OSA.

The current systematic review assessed the accuracy of four self-reported questionnaires for OSA screening against polysomnography as the reference test. The SQB had the highest sensitivity regarding the prediction of mild and severe OSA (97.55% and 98.7% respectively). However, the highest specificity in terms of the detection of mild and severe OSA indicated for the BQ (90% and 80% respectively). The SQ had the highest sensitivity (100%) and specificity (92.3%) for the predicting of moderate OSA in comparison to other questionnaires. Although, the accuracy of these findings are a matter of debate because of high prevalence of OSA among sleep clinic patients as the most studied population and the absence of a standard definition for the disease in various validation studies.

Features of an appropriate screening questionnaire varies according to surveying population. Diagnosis of true positive subjects in a clinical setting using a questionnaire with high sensitivity minimize negative health consequences and cost of unnecessarily diagnostic tests. Therefore, stratifying patients based on a screening tool with high sensitivity among populations that are susceptible to OSA such as sleep clinic patients has of great importance. Polysomnography, the gold standard for diagnosis of OSA, is an expensive and time-demanding procedure; thus, it is necessary to decrease the number of false-positive subjects in general population by a screening tool with high specificity. Most of included studies in our systematic review were conducted on sleep clinic patients, indicating that it is very important that a screening questionnaire has a high sensitivity and dose not miss any cases of OSA.

There is also a lack of a standard definition for OSA in various studies, which investigated the validity of OSA screening questionnaires against PSG. A recent meta-analysis indicated that berlin questionnaire had a moderated sensitivity and specificity in general population for the hypopnea definition of 3% oxygen desaturation. However, its sensitivity decreased when the hypopnea definition of 4% oxygen desaturation was applied [57, 58]. It supposed that OSA definition would affect the accuracy of validation studies.

Exploring the validity of various screening questionnaires for OSA in general, population against the reference test is necessary. While, the majority of conducted studies on the accuracy of these screening tools done on sleep clinic patients with a possible bias because of high risk of the disorder among this population. Therefore, it is not possible to generalize the results of these studies to general population.

The findings of the present systematic review indicated that SBQ and SQ are appropriate screening tools for OSA in sleep clinic patients. Further validation studies of studied questionnaires on community population are warranted.

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