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ORIGINAL ARTICLE

Development and validation of a questionnaire to identify patients with sleep apnea in Mexican population

Mexican questionnaire to identify sleep apnea

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Abstract
Purpose To develop and validate a questionnaire to identify patients with obstructive sleep apnea (OSA) in Mexican population.
Methods We performed a cross-sectional study to develop and validate an instrument in Spanish language, consistent in an 18-item questionnaire. We enrolled patients seen from July 2008 to August 2009. We evaluated the internal consistency with the Kuder Richardson coefficient, a value greater than 0.70 was considered a good index correlation. Sensitivity, specificity, and positive and negative predictive factor was obtained with standard methods by comparison with polysomnographic results. Validity of Mexican questionnaire at baseline and follow-up was assessed using Pearson correlations coefficient.
Results We enrolled 100 patients. The initial pool comprised 25 items, four items were considered confusing and they were omitted; then, a preliminary questionnaire comprising 21 items was obtained, and three items were removed by presenting a response rate lesser than 90%, yielding a total of 18 items for the final questionnaire. This evaluation was performed stratifying in groups related to severity of illness. Snoring was the question with the greatest sensitivity to detect OSA; and obesity class I was the criteria with greatest specificity to detect OSA.
Conclusion The screening tool proposed in this study has the advantages of being quick, inexpensive, easy to apply and reproducible, and the result has reliability with acceptable sensitivity; this is a symptom-based questionnaire with good predictive ability and it will avoid unnecessary sleep studies in the subjects who are not at high risk for having OSA.

Keywords Obstructive sleep apnea · Epworth sleepiness scale · *Polysomnography* · Reliability · Validity · Mexican questionnaire

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Introduction

Obstructive sleep apnea (OSA) is a highly prevalent disease characterized by recurrent episodes of upper airway obstruction that result in recurrent arousals and episodic oxyhemoglobin desaturations during sleep [1]. Epidemiologic studies estimate that the condition affects 2-4% of middle-aged adults and only a small portion of the cases in this group of adults have been diagnosed; this is related to insufficient awareness of sleep apnea among physicians and the public at large [2]. Overnight polysomnography (PSG) is considered to be the gold standard for diagnosis of OSA, in a sleep laboratory, which generally incorporates recording of electroencephalogram, electro-oculogram, chin electromyogram, snoring (microphone), thermistor, electrocardiogram, pulse oximetry, and tibialis anterior electromyogram [3]; sleepiness in these patients appears to be correlated with OSA severity, as determined by measurement of apnea and hypopnea index

(AHI). However, prohibitive cost of the test and long waiting lists limit its widespread access. Symptoms questionnaires have been developed to predict presence of OSA, and have been shown to be helpful in sleep referral clinics and community surveys [4–6]. The Epworth sleepiness scale is a simple, self-administered questionnaire which is shown to provide a measurement of the subject's general level of daytime sleepiness [5, 7]. The Berlin Questionnaire asks about risk factors for sleep apnea, namely snoring behavior, waketime sleepiness or fatigue, and the presence of obesity or hypertension [8].

Berlin Questionnaire is useful to screen for sleep apnea in a primary care population and may be more convenient and less costly than polysomnography; it will detect important symptoms distributions and permit risk grouping in the absence of a physician–patient encounter. The sensitivity of 86% for an AHI >5 is higher than that of strategies currently used in clinical practice [9]. There are no validated questionnaires in Latin American populations; thus, we have attempted to develop and validate a questionnaire to identify patients with sleep apnea in such population.

Patients and methods

Design

We performed a cross-sectional study to develop and validate an assessment instrument, in a form of an 18-item questionnaire.

Subjects

We enrolled patients seen from July 2008 to August 2009 at the Pneumology Sleep Clinic, Hospital General "La Raza" National Medical Center at the Instituto Mexicano del Seguro Social. We enrolled adults between 18 and 65 years old, who presented in our clinic with suspected symptoms of OSA. Patients with OSA diagnosis with positive airway pressure treatment and the subjects who did not complete the protocol were excluded.

Measurements

Item selection Items were selected from the literature to elicit factors or behaviors that, across studies, consistently predicted the presence of sleep disordered breathing; in addition, we used questions internationally standardized and validated in its Spanish version. Useful questions were those with greater sensitivity and specificity defining those above 60%, for detecting OSA.

The domains of the Mexican questionnaire (MQ) were predefined based on (1) OSA definition, (2) the focus group interviews that informed the items selection process, and (3) expert opinion. Based on this, the domains proposed were symptoms and comorbidities.

Each item was allocated to one of the predefined domains based on the following criteria: (1) Each item's face validity was determined by an expert panel formed by five expert respiratory physicians in understanding OSA. The selected items were combined to form the preliminary questionnaire, questions were raised with closed answer "yes" or "no", this was given to 50 control healthy subjects, ability for reading and answering items was needed in order to assess most suitable questions. They evaluated if the items were understandable and those that caused confusion were eliminated. Subsequently, the preliminary questionnaire was applied to 30 patients interviewed, being eliminated those questions with a response rate less than 90%.

Reproducibility The questionnaire was applied to 30 participants to ensure the 2-week time interval, then, we calculated a kappa coefficient to measure test-retest reliability, excluding those questions of the questionnaire with a coefficient less than 0.60.

The questions with a better response rate and consistency were used to develop the final questionnaire.

For the implementation of the final questionnaire, a group of 100 patients was selected randomly among individuals who attended in the outpatient department of respiratory medicine and/or in the sleep clinic at the Hospital General "La Raza" National Medical Center and the study was scheduled with polysomnography 3–4 weeks later to its application.

We evaluated the internal consistency with the Kuder Richardson coefficient, a value greater than 0.70 was considered a good index correlation.

Predictive validity We compared the results of the questionnaire with polysomnography, which is considered the gold standard for diagnosis of OSA.

Polysomnography

The study of PSG was performed with a polysomnograph Healthdyne ALICE 3 Technologies, which consisted of simultaneous recording of neurophysiological and respiratory variables were evaluated for quantity and quality of sleep, identified the different respiratory events and their impact cardiorespiratory and neurophysiological. The PSG was performed at night, with a record of greater than 6.5 h included at least 180 min of sleep.

The PSG for each patient was performed by one pulmonologist physician specializing in neurophysiology, who was unaware of the previous result of the question-

Table 1 Concordance between items

Items	Kappa
1	0.88
2	0.71
3	0.66
4	0.76
5	1
6	0.77
7	0.70
8	0.86
9	0.78
10	0.66
11	0.72
12	0.65
13	0.68
14	0.92
15	0.93
16	0.79
17a	1
17b	1
17c	1
18	0.28**

**Concordance <60

naire. We used the OSA definition according to the American Thoracic Society consensus: mild AHI>5 (but <15 events/hour): moderate AHI ≥ 15-30, severe AHI> 30 events/hour. We analyzed the results of the polysomnography, including AHI, and a comparison with the score of the final questionnaire was tested, we subsequently established the concordance with the Pearson correlation coefficient. We estimated the sensitivity, specificity, and the positive predictive value and negative predictive value. Statistical tests were performed using SPSS 17.0 software.

Table 3 Patients comorbilities

Diagnosis	Percentage
Obese class I	27
Obese class II	18
Obese class III	23
COPD gold I	13
COPD gold II	23
COPD gold III	1
COPD gold IV	4
High blood hypertension	62
Polycythemia	18
Diabetes mellitus	18
Dyslipidemia	57

COPD chronic obstructive pulmonary disease

Statistical analysis

Means and standard deviations were used for evaluate basal characteristics.

The stability, construct validity, and responsiveness of the MQ were examined in this study. The stability of the MQ was estimated by measuring the test-retest reliability and internal consistency of the questionnaire. The utility of the MQ was assessed using sensitivity, specificity, and the positive and negative predictive values.

Sensitivity, specificity, and positive and negative predictive factor was obtained with standard methods by comparison with polysomnographic results. The strength of relationship between weight and neck diameter with AHI was estimated by Pearson correlation coefficient.

Table 2 Basal characteristics and espirometry values (n=100)

	Minimum	Maximum	Medium	Std deviation
Age	29	65	55.23	11.59
Blood systolic pressure (mmHg)	80	170	121.10	16.32
Blood diastolic pressure (mmHg)	50	110	78.75	11.66
Mallampathy	1	4	3.49	.90
Height (m)	1.4	1.8	1.588	.105
Weight (kg)	52	140	87.37	18.59
Neck (cm)	32	52	41.40	4.02
BMI (Kg/m^2)	21	71	34.52	8.54
Smoking (pack/year)	0	100	8.59	17.56
FVC (%)	44	124	89.30	16.27
FEV1 (%)	38	127	88.23	18.34
PEF (%)	32	172	100.34	23.21
FEF 25-75 (%)	11	151	69.39	25.83

Table 4 Patients AHI score

AHI	Patient (%)
0-5	10
6-15	11
16-30	21
>30	58

Validity of the MQ at baseline and follow-up was assessed using Pearson correlations coefficient.

Results

Item selection The initial pool comprised 25 items, four items were considered confusing and they were omitted; then, a preliminary questionnaire comprising 21 items was obtained.

Item reduction The preliminary questionnaire was applied to 50 subjects and three questions by presenting a response rate less than 90% were removed, yielding a total of 18 items. In addition one item was removed because the kappa coefficient was less than 0.60 (Table 1).

We conducted a systematic search of Medline internet and found a total of four questionnaires, validated for OSA detection; these questionnaires were reviewed by an expert committee of five pulmonologists obtaining a total of 25 items. In the initial survey, 25 items were evaluated; for the face validity, we removed four items that were confusing, yielding a total of 21 items.

Reproducibility The preliminary questionnaire obtained was applied to 30 of 50 patients previously interviewed; they participated in the test-retest reliability phase of questionnaire development, they complete the final version of MQ 2 weeks apart.

The results of correlation coefficients for the 18 items are shown in Table 1. One item was removed because the kappa coefficient was less than 0.60.

By using the Richardson coefficient the internal consistency was 0.7562. The final questionnaire was applied to 100 patients, of whom 66% were men, mean ± SD age of 55.23±11.59, weight of 87.37±18.59, body mass index (BMI) of 34.52 8.54. The clinical characteristics of patients and values obtained by spirometry are shown in Table 2. Regarding the assessment of weight, four (4%) patients were within normal range regarding their weight, 28 (28%) were overweight, degree of obesity was classified according to BMI according to WHO classification, as well as associated comorbilities analyzed each of the 100 patients. Among patients who had confirmed OSA diagnosis, we evaluated the comorbilities: 28% had a history of chronic obstructive pulmonary disease, 54% systemic arterial hypertension, and 18% polycythemia (Table 3).

Polysomnography was performed on 100 patients; it was recorded as AHI value (Table 4). We determined the sensitivity, specificity, and the positive and negative predictive values of each of the survey questions. This evaluation was performed stratifying in groups related to severity of illness (Tables 5, 6, and 7).

Item 9 (related to the presence of snoring) was the question with greater sensitivity (sensitivity 96%) to detect mild OSA in the group of patients with an AHI>5. Item 17b (obese class I) and 17c (obese class II) were the questions with greater specificity for detection OSA (specificity 80%); positive predicted values for all items in the group with AHI >5 were above 80% (Table 5)

Item 9 was the most sensitive too (sensitivity 96%) in group with AHI ≥15; however, when we evaluated specificity, item 6 (automobile accidents secondary to somnolence) was the best (specificity 100%); positive predicted values for all items in the group with AHI ≥15 were above 75% (Table 6).

Finally, in the group with AHI ≥30, the same item (question 9) was the most sensitive (sensitivity 98%); and the most specific question was 17b (specificity 95%; Table 7).

When we evaluated specificity to detect OSA, we found low values in the group with AHI ≥5; however,

Table 5 Sensitivity and specificity of the items to detect: mild OSA (AHI >5)

	Item 1 (%)	Item 2 (%)	Item 3 (%)	Item 4 (%)	Item 5 (%)	Item 6 (%)	Item 7 (%)	Item 8 (%)	Item 9 (%)	Item 10 (%)	Item 11 (%)	Item 12 (%)	Item 13 (%)	Item 14 (%)	Item 15 (%)	Item 16 (%)	Item 17a (%)	Item 17b (%)	Item 17c (%)
Sensitivity	81	38	80	90	40	15	85	84	96	78	62	61	67	57	58	24	28	12	30
Specificity	40	70	30	50	50	100	1	20	1	30	1	30	20	37	20	60	70	80	80
PPV	92	92	91	94	88	100	89	90	90	91	86	88	88	90	86	84	89	84	93
NPV	19	11	14	35	8	11	7	12	25	13	2	7	5	7	5	8	9	9	11
Performance	77	42	75	86	41	23	78	78	88	74	57	58	63	55	55	28	33	19	35

PPV positive predictive value, *NPV* negative predictive value

Table 6 Sensitivity and specificity of the items to detect: Moderate OSA (AHI > 15)

	Item 1 (%)	Item 2 (%)	Item 3 (%)	Item 4 (%)	Item 5 (%)	Item 6 (%)	Item 7 (%)	Item 8 (%)	Item 9 (%)	Item 10 (%)	Item 11 (%)	Item 12 (%)	Item 13 (%)	Item 14 (%)	Item 15 (%)	Item 16 (%)	Item 17a (%)	Item 17b (%)	Item 17c (%)
Sensitivity	81	40	80	90	43	17	85	85	96	78	62	63	67	57	57	26	28	13	30
Specificity	30	70	25	30	66	100	10	20	5	25	25	45	25	40	25	75	70	90	75
PPV	82	84	81	83	84	100	79	81	80	80	76	82	78	82	75	80	79	84	82
NPV	28	22	23	42	21	22	14	25	25	22	14	23	16	15	12	20	19	20	21
Performance	71	46	69	78	47	33	70	72	78	68	55	60	59	54	51	36	37	29	39

these values improved around 40% in the groups with AHI ≥15 and AHI ≥30.

Item 17b was the less sensitive (sensitivity 12%) question in the group with AHI >5; in the same group item, 7, 9, and 11 items were the less specific (specificity 10%). Item 17b was the less sensitive question (sensitivity 13%) in the group with AHI ≥15; item 9 were the less sensitive questions (specificity 5%). Finally, item 6 was the less sensitive in group ≥30 (sensitivity 15); item 9 was the less specific question (specificity 7%) in the group with AHI ≥30 (Tables 5, 6, and 7).

Using a Pearson correlation coefficient, the correlation between the diameter of the neck and AHI with a moderate correlation (R=0.417, P<0.001) was determined. The total weight of the subjects and the AHI also found a moderate correlation (r=0.331, P=0.001).

Discussion

The aim of this study was to develop and validate a questionnaire to detect OSA, constructed at the department of Pulmonology, Sleep Clinic in Hospital General "La Raza" National Medical Center. A modified symptom-based questionnaire was used to identify the patients at risk for OSA in the Mexican population. The modification was done to suit questions to our population.

Our study confirms the importance of questionnaires in OSA diagnosis; this inexpensive and easy to apply tool should be used as a diagnostic test in clinical practice.

We also found items with greater sensitivity and specificity such as snoring to detect OSA.

The final version of the MQ contained 17 items covering 12 domains of daytime symptoms, two domains of nocturnal symptoms, and three domains about OSA's comorbidities.

The internal consistency reliability was acceptable, in line with recommendations with a Kuder Richardson coefficient >0.70.

Thirty patients participated in the test-retest reliability phase of questionnaire development by completing the final version of the MQ twice, 2 weeks apart; high test-retest reliability was obtained for all domains, with a good intraclass correlation coefficient. High test-retest reliability provides the basis for good responsiveness of our questionnaire.

Final questionnaire was applied to 100 patients; items related to excessive daytime sleepiness and snoring were shown to be more sensitive than other questions for detecting OSA.

The gold standard diagnostic study was overnight polysomnography. For our study population, an AHI >5/hour was used as cut-off point for defining OSA, because our study was performed to validate the questionnaire in subjects at risk for OSA

Previous studies by Deegan et al., concluded that OSA's clinical value detection was increased when AHI values were above 15 [10]; in our study, we decided to perform different cutoff points in order to determine more accurate test and the usefulness of determining sensitivity, specific-

Table 7 Sensitivity and specificity of the items to detect: Severe OSAS (AHI>30)

	Item 1 (%)	Item 2 (%)	Item 3 (%)	Item 4 (%)	Item 5 (%)	Item 6 (%)	Item 7 (%)	Item 8 (%)	Item 9 (%)	Item 10 (%)	Item 11 (%)	Item 12 (%)	Item 13 (%)	Item 14 (%)	Item 15 (%)	Item 16 (%)	Item 17a (%)	Item 17b (%)	Item 17c (%)
Sensitivity	84	42	78	91	44	15	83	84	98	83	66	62	64	52	61	32	25	18	32
Specificity	29	68	19	22	64	88	9	17	7	29	36	39	24	34	39	82	65	95	75
PPV	63	65	58	62	65	66	57	59	60	62	60	59	55	55	59	73	51	84	65
NPV	57	45	38	64	43	40	28	43	75	54	42	42	32	31	41	45	38	44	43
Performance	62	53	54	63	52	44	53	57	61	61	54	53	48	45	52	53	42	50	50

ity, and predictive values; these values were improved with progressively higher cutoffs points.

The most sensitivity items were those related to daytime sleepiness (items 1, 3, 4, 7, and 8); our results were similar to those described by Murray et al., in Epworth scale, however, we included other questions related to comorbilities [11, 12].

In this study, we found a better sensitivity and specificity when AHI was between 15 and 30; these results are consistent with those reported by Netzer et al., in the Berlin questionnaire, founding 86% sensitivity, 77% specificity, and 89% positive predictive value, when AHI was greater than 5 [8, 9].

An AHI >30 was associated with a higher sensitivity and negative predictive value with snoring item; nevertheless, we only evaluated snoring presence or absence, in contrast to Resta et al., who evaluated snoring intensity; however, the results obtained in our study were similar for detection of severe disease [13].

Nasal congestion has been related to OSA in Wisconsin cohort; although, we did not find an association with the disease; in addition, nasal congestion has been associated to snoring in experimental and epidemiological studies; however, in our study, this symptom had low sensitivity and specificity for the OSA early screening [14].

The Berlin questionnaire is a useful tool to screening patients with OSA; however, it has some drawbacks such as different options for a reactive response that can do a simultaneous confusing, and so does not cover total symptoms as a syndrome; in our questionnaire, we try to avoid such problems with precise answers and items easy to understand for our population [8].

Our findings are consistent with those of Barbe et al., when they showed an increase in automobile accidents and these were related to OSA, particularly in subjects with severe disease [15, 16].

When we evaluated the relationship between the diameter of the neck and weight with OSA, the neck circumference (cm) was identified as the anthropometrical measure associated with the severity of apnea; our findings were similar to those obtained by the international data showed by Daltro [17], and with the national data revised by Villa [18], and Valencia-Flores [19], where they concluded that patients diagnosed with obesity and increased in neck diameter are an important risk factor for sleep breathing disorders.

The long-term OSA effects include hypertension, which is an important societal concern; in this study, results were similar to those found by Peppard and Young, regarding the association between hypertension and the diagnosis of OSA [20, 21].

We consider obesity when BMI>30 kg/m^2 and the findings related to this problem were similar in the Berlin questionnaire. The items related to other clinical aspects as forgetfulness, nasal obstructions, nocturia, decreasing in libido, and headache, have low specificity; other comorbidities including patient age that could give similar symptoms could explain this association.

According to Choi et al. [22], patients with OSA have higher blood viscosity, which correlates positively with indices of sleep apnea severity; in the current study, we considered the relationship between OSA and polycythemia diagnosis; however, more research is needed to investigate the role of polycythemia in our questionnaire after controlling possible confounding variables.

The screening tool proposed in this study has the advantages of being quick, inexpensive, easy to apply and reproducible; and the result has reliability with acceptable sensitivity, concluding that this is a symptom-based questionnaire with good predictive ability and it will avoid unnecessary sleep studies in the subjects who are not at high risk for having OSA.

The study took place in a single medical center and all patients were taken from one office setting (i.e., education level and expectations of referred patients, narrow demography, etc); patients included were Hispanic patients, so this questionnaire should be evaluated in other ethnic groups; then, we consider that this questionnaire can be used only in Mexican population.

Another limitation of our study was a small sample size and we did not establish a score index with the items.

A scoring index to detect OSA should be developed in next studies.

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