



Original Article

Cultural adaptation and evaluation of the measurement properties of the Berlin Questionnaire for Brazil



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ARTICLE INFO

Article history:

Received 25 October 2018

Received in revised form

7 March 2019

Accepted 25 March 2019

Available online 23 April 2019

Keywords:

Sleep apnea

Obstructive

Questionnaire

Validation studies

Translating

ABSTRACT

Objective: to produce the Brazilian version of the Berlin Questionnaire (BQ) with evidence of reliability and validity.

Method: The cultural adaptation was carried out in the following stages: translation, synthesis of translations, back-translation, evaluation by an expert committee and pre-test with 30 participants. Next, the psychometric properties were evaluated with 104 participants who answered the Brazilian version of the BQ and underwent polysomnography (PSG). They also completed a sociodemographic and clinical characterization instrument and the Epworth Sleepiness Scale. Reliability was assessed concerning homogeneity of the items (internal consistency), and criterion validity was tested by comparing the Brazilian version of the BQ with the apnea and hypopnea index (AHI) obtained through PSG.

Results: The Brazilian version of the BQ presented evidence of semantic-idiomatic, conceptual and cultural equivalence, with good acceptability and feasibility. The findings demonstrated the reliability of the measure (Cronbach's alpha 0.74). The instrument presented a sensitivity of 81.3%, 86.2%, and 93.8%, and specificity of 82.5%, 54.7% and 50.0% for the risk stratification of obstructive sleep apnea according to the AHI ≥ 5 , ≥ 15 and ≥ 30 events per hour, respectively. It should be emphasized that the BQ is a screening instrument for obstructive sleep apnea (OSA) and should be combined with a clinical evaluation and later confirmed with PSG.

Conclusion: The Brazilian version of the Berlin Questionnaire was reliable and valid in the study population.

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1. Introduction

Obstructive sleep apnea (OSA) is a disorder that consists of multiple episodes of upper airway obstruction during sleep, resulting in decreased oxyhemoglobin saturation and various awakenings, chronically compromising sleep quality [1,2]. In a recent systematic review, the estimated prevalence of OSA in the general population was from 9% to 38% and higher in men [3]. In Brazil, an epidemiological study conducted with the adult population in the city of São Paulo estimated the prevalence to be 32.9% (men 40.6% and women 26.1%), with predictive factors being obesity, age between 60 and 80 years and male sex [4].

The gold standard for the diagnosis of OSA is polysomnography (PSG) [1], which is expensive [5] and is not available in many Brazilian cities. However, the initial assessment of OSA risk can be performed using a reliable and validated instrument. Among the instruments for screening for OSA risk, the Berlin Questionnaire (BQ) is widely used [6] and is an instrument that provides a good measurement for predicting moderate to severe OSA [7]. The BQ was developed for the identification of patients at risk for OSA at the Conference on Sleep in Primary Health Care in 1996, in Berlin, Germany, and validated by Netzer and colleagues in 1999 [8]. In Brazil, there are a large number of studies providing a free translation and the Portuguese version of the BQ validated in Portugal. However, it should be highlighted that there are linguistic and cultural differences between the two countries.

Proper screening for OSA by primary care providers is essential to establish the diagnosis and to initiate appropriate treatment [9].

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Thus, this study aimed to produce the Brazilian version of the Berlin Questionnaire (BQ-BR) with evidence of validity and reliability. Specific aims were the cultural adaptation of the BQ to Brazilian Portuguese, verifying the feasibility, acceptability, reliability and criterion validity.

2. Method

After authorization from the author of the Berlin Questionnaire, we performed a methodological study, carried out in two phases: (1) cultural adaptation of the BQ; and (2) evaluation of the measurement properties. The study was approved by the Research Ethics Committee of the State University of Campinas (CAAE: 78538517.0.0000.5404).

2.1. First phase - cultural adaptation

The Berlin Questionnaire was submitted to the cultural adaptation process following the published recommendations widely used in studies of this nature [10,11]. Five stages were implemented for the translation and adaptation process: 1. translation - after obtaining the author's consent, the BQ was translated into the Portuguese language of Brazil by two independent bilingual translators whose first language was Brazilian Portuguese; only one of the translators was informed about the concepts and aims of the questionnaire. 2. synthesis of the translations - the translated versions (T_1 and T_2) were analyzed and compared by the researchers and by a mediator - professional translator. Discrepancies were analyzed until a consensus was obtained, thus producing the translated version of the BQ (T_1 - T_2). 3. Back-translation - the translated version of the BQ was translated into English by two other independent bilingual translators who did not participate in the first stage, whose first language was English and who did not know the concepts/purpose of the instrument. At the end of this stage, two versions - back-translation 1 (BT_1) and back-translation 2 (BT_2) were obtained. 4. Evaluation by the Committee of Judges - seven bilingual experts evaluated the translated version in terms of semantic, idiomatic, cultural and conceptual equivalence. 5. pre-test - the pre-final adapted version was given to 30 subjects aged 18 years or over. After responding to each item in the questionnaire, the participants were interviewed to investigate perceived difficulties in understanding the statements and the response alternatives, as well as to detect difficult-to-understand terms. The feasibility and acceptability of the pre-final version of the Brazilian BQ were evaluated in this stage.

2.2. Second phase - validation

The validity assessment related to the criteria was used to verify the association between the target instrument (BQ-BR) and a pre-established criterion (apnea and hypopnea index based upon PSG). The version of the BQ adapted for Brazilian Portuguese was given to 104 participants from October 2017 to March 2018. All participants who performed a full night's PSG in the laboratory located in a clinic specializing in sleep disorders were aged 18 or over, were able to respond to the instruments without assistance and were considered eligible. Participants using Continuous Positive Airway Pressure (CPAP) and performing PSG for CPAP titration were excluded. Participants were referred for PSG for various reasons, such as snoring or confirmation of OSA diagnosis (36.5%), complaints of insomnia, insomnia symptoms, poor sleep and daytime sleepiness (21.8%), and other complaints (41.7%).

The data were collected individually by the researchers. All participants were informed about the aims of the study and signed a consent form. Data were collected on sociodemographic and

clinical characteristics, the Epworth Sleepiness Scale validated in Brazil - ESE-BR [12], and the BQ-BR version. After the data collection, the patients underwent PSG.

2.3. Data collection instruments

Sociodemographic and clinical characteristics for all the participants included information regarding sex, date of birth, marital status, education, current work situation, weight, height, arterial hypertension, diabetes mellitus, history of stroke, practicing physical activity and neck circumference. Excessive daytime sleepiness (EDS) was measured with the ESE-BR [12]. This instrument has eight questions about the likelihood of falling asleep performing daily activities. Responses are assigned a score of 0–3 and the sum of this score results in the final score. The overall score ranges from 0 to 24, with scores above 10 suggesting EDS.

Stratification of obstructive sleep apnea risk was assessed with the adapted Brazilian version of the BQ (Annex 1). This instrument consists of 10 items, divided into three categories (1. snoring and witnessed apnea, 2. daytime sleepiness, and 3. arterial hypertension/obesity). Category 1 can range from 0 to 6 points and is considered positive when the score is 2 points or more. Category 2 ranges from 0 to 3 points and is considered positive when the score is 2 points or more. Category 3 will be positive if the participant reports that he/she has high blood pressure or a body mass index (BMI) >30 kg/m². The final score will indicate a high risk for OSA when two or more categories are positive and low risk when there is no positive score in the categories or a positive score in only one category.

2.4. Polysomnography

All PSGs were performed in the laboratory by medical staff and technicians trained for the procedure. The equipment used was the Alice 5[®] polysomnographer – Philips; the sensors were placed according to the recommendations of the Manual of the American Academy of Sleep Medicine (AASM - [13]). The AHI was the criterion used for the diagnosis and definition of OSA severity (mild ≥ 5 , moderate ≥ 15 , and severe ≥ 30 events per hour) [13].

2.5. Statistical analysis

Data were digitalized, organized in a spreadsheet and analyzed using the Statistical Package for Social Sciences version 22.0 (SPSS) and Statistical Analysis System for Windows version 9.4 (SAS) programs. Descriptive and inferential statistics were used. For the content validity performed by the committee of judges, the Content Validity Index of the items (CVI-I) $\geq 80\%$ was used.

The comparison between categorical and numerical variables was performed using the Mann–Whitney U test for data with non-normal distribution or the unpaired Student's t-test for data with a normal distribution [14]. The association between categorical variables was measured using the Chi-squared test [14] or, when the assumptions of this test were not fulfilled, using Fisher's exact test [15].

The analysis of internal consistency was performed by calculating the Kuder-Richardson Formula 20 (KR-20) [16] and Cronbach's alpha coefficient. The KR-20 test was used for internal consistency of the overall score of the instrument due to its dichotomous questions, for which it is considered appropriate. Cronbach's alpha coefficient was used for the instrument responses that can be quantified using a Likert scale: Category 1, questions two, three and five and Category 2, questions six, seven and nine.

The evaluation of the criterion validity of the BQ-BR, the properties of sensitivity, specificity, positive predictive value (PPV),

negative predictive value (NPV), positive likelihood ratio (PLR) and negative likelihood ratio (NLR) were calculated through the association with the gold standard. The AHI was used to establish the diagnosis and severity (AHI: mild ≥ 5 , moderate ≥ 15 , and severe ≥ 30 events per hour). The significance level adopted for the statistical tests was 5%, that is, $p < 0.05$.

3. Results

3.1. Cultural adaptation

The results of the content validation of the items (CVI-I) was 1.00 in 12 of the 13 evaluated items. All the items in the questionnaire obtained an agreement rate among the members of the committee higher than the CVI-I 0.80 stipulated. Only question six (Are you tired after sleeping?) obtained CVI-I = 0.86. However, some of the experts made suggestions related to question six of the BQ, and these were taken into consideration. The Brazilian version of the BQ was re-evaluated by the Committee of Judges and submitted to the pre-test stage. In this stage, the respondents reported comprehending the items and having no difficulties interpreting the response items. Question eight (Have you ever fallen asleep while driving?) was not answered by 36.7% of the participants as they did not drive. The author of the original instrument authorized the addition of a new response item for this question (“Not applicable”).

Regarding feasibility, the results suggest that the Brazilian version of the BQ is an easy-to-use instrument, with a mean completion time of 2.53 min. All participants answered all the items of the BQ-BR (100%), which demonstrates easy comprehension and good acceptability of the questionnaire.

3.2. Evaluation of the measurement properties of the Brazilian version of the BQ

3.2.1. Characterization of the sample

The evaluation of the psychometric properties of the questionnaire was performed with a sample of 104 participants. The mean age of the participants was 49.9 years, 55.8% were male, 68.3% had partners, 60.6% performed paid work, and the mean length of formal schooling was 14.4 years. Regarding the comorbidities investigated, 36.5% were hypertensive, 34.6% were obese, 14.4% had hypothyroidism, 7.7% had diabetes mellitus, and 1.9% had suffered a stroke. The majority (65.4%) did not engage in physical activity.

Based on an AHI ≥ 5 events per hour, OSA was identified in 61.6% ($n = 64$) of the participants, being mild in 33.7% ($n = 35$), moderate in 12.5% ($n = 13$) and severe in 15.4% ($n = 16$). The comparison of sociodemographic and clinical characteristics according to the risk stratification for OSA is presented in Table 1.

The association between risk for OSA, from the classification of the BQ-BR, according to sociodemographic and clinical variables is presented in Table 2.

3.3. Reliability

The reliability of the Brazilian version of the BQ was evaluated with regard to the homogeneity of the items (internal consistency) using the KR-20 and Cronbach's alpha. The results of the analysis of correlation item - total, KR-20 coefficient if item excluded and total KR-20 are presented in Table 3. The data show that the KR-20 coefficient for the total score was 0.59. When question 08 was excluded, the KR-20 value obtained for the total score was 0.65.

Cronbach's alpha coefficient calculated for Categories 1 and 2 of the BQ-BR was 0.74 (Table 4).

Table 1

Comparison of the sociodemographic, clinical and polysomnographic characteristics of the sample of participants in the validation of the Berlin Questionnaire - BR according to the risk stratification for Obstructive Sleep Apnea.

	Total ($n = 104$) mean (SD)	Risk stratification for OSA ^a (Berlin Questionnaire - BR)		P-value
		low risk ($n = 45$) mean (SD)	high risk ($n = 59$) mean (SD)	
Age, years	49.9 (14.9)	46.4 (12.3)	52.5 (16.3)	0.082 ^e
Body mass index, kg/m ²	29.3 (6.1)	25.7 (3.5)	32.1 (6.3)	<0.001 ^e
Neck circumference, cm	39.1 (4.8)	36.7 (4.2)	40.9 (4.5)	<0.001 ^d
Epworth Sleepiness Scale, score	9.5 (5.0)	8.3 (4.3)	10.7 (5.3)	0.036 ^d
Polysomnography parameters				
Sleep efficiency, %	76.6 (13.3)	75.0 (14.9)	77.7 (11.9)	0.564 ^e
AHI ^b	14.8 (18.2)	5.9 (10.6)	21.6 (19.9)	<0.001 ^e
AHI ^b REM	17.2 (21.7)	8.2 (14.1)	24.4 (23.9)	<0.001 ^e
AHI ^b NREM	15.8 (21.1)	5.6 (10.7)	23.9 (23.7)	<0.001 ^e
SpO ₂ ^c mean, %	94.9 (2.6)	96.0 (1.1)	94.1 (2.6)	<0.001 ^e
SpO ₂ ^c minimum, %	83.0 (11.8)	89.3 (5.8)	78.0 (12.9)	<0.001 ^e
Total sleep time with SpO ₂ ^f <90%	4.3 (10.8)	0.5 (1.8)	7.4 (13.6)	<0.001 ^e

^a OSA: obstructive sleep apnea.

^b AHI: Apnea and hypopnea index.

^c SpO₂: oxyhemoglobin saturation.

^d p-value obtained through unpaired Student's t-test.

^e p-value obtained through the Mann-Whitney test.

^f p-value significance < 0.05.

3.4. Performance of the BQ-BR

3.4.1. Sensitivity, specificity, positive (PPV) and negative predictive values (NPV) and positive and negative likelihood ratio values

According to the BQ-BR, 56.7% ($n = 59$) of the participants were identified with high risk for OSA among the 104 studied. Among the individuals at high risk in the questionnaire stratification, in 88.1% ($n = 52$) OSA (AHI ≥ 5) was confirmed by PSG (Table 5).

The values of sensitivity, specificity, PPV, NPV, PLR, and NLR were calculated for all cutoff points (mild, moderate and severe OSA), considering the AHI. Significant discrimination was shown; thus the screening procedure for OSA could be based on the BQ-BR, as shown in Table 6. Considering the cut-off point of AHI ≥ 30 , an increase in sensitivity was observed for 93.8%, indicating a better ability to correctly identify participants with severe OSA, and an NPV of 97.8%, corresponding to 2.2% false negatives.

Category 1 of the BQ-BR presented the highest percentage of positivity, 72.1% ($n = 75$), regarding high risk, followed by category 3, 51.0% ($n = 53$), and category 2, 42.3% ($n = 44$). When the accuracy of each BQ-BR category was evaluated, a sensitivity of 90.6%, 45.3% and 67.2% and a specificity of 57.5%, 62.5%, and 75.0% were found for categories 1, 2 and 3, respectively (results not presented in tables).

4. Discussion

4.1. Cultural adaptation of the questionnaire

The choice of the BQ was due to it being a widely used [6] and easy to understand questionnaire, the purpose of which is to assess the risk of OSA. Considering the relevance of OSA screening, the BQ-BR translated and adapted to the Brazilian culture may provide important information for the referral of individuals by healthcare providers for appropriate interventions.

The cultural adaptation performed according to established international norms assures the reproducibility of the results and

Table 2
Distribution of sociodemographic and clinical variables according to the risk stratification for OSA from the Berlin Questionnaire - BR.

Variable	Berlin Questionnaire - BR				P-value
	Low		High		
	n	%	n	%	
Sex					0.042^a
Male	20	34.48	38	65.52	
Female	25	54.35	21	45.65	
Work situation					0.003^a
Inactive	6	20.69	23	79.31	
Active	39	52.00	36	48.00	
Practice physical activity					0.511 ^a
No	31	45.59	37	54.41	
Yes	14	38.89	22	61.11	
Body mass index					<0.001^a
≤30 kg/m ²	43	63.24	25	36.76	
>30 kg/m ²	2	5.56	34	94.44	
Arterial hypertension					<0.001^a
No	40	60.61	26	39.39	
Yes	5	13.16	33	86.84	
Diabetes mellitus					0.009^b
No	45	46.88	51	53.13	
Yes	0	0.00	8	100.00	
Hypothyroidism					0.842 ^a
No	36	43.90	46	56.10	
Yes	7	46.67	8	53.33	
Smoking Habit					0.447 ^a
Non-smoker	35	45.45	42	54.55	
Smoker/Ex-smoker	10	37.04	17	62.96	
Neck circumference					0.001^a
<40 cm	34	60.71	22	39.29	
≥40 cm	11	22.92	37	77.08	
Apnea and hypopnea index					<0.001^a
<5	33	82.50	7	17.50	
≥5	12	18.75	52	81.25	
How often have your breathing pauses been noticed? (Question 5)					0.048^a
0 points (answer C, D or E)	43	46.74	49	53.26	
2 points (answer A or B)	2	16.67	10	83.33	
Excessive daytime sleepiness					0.007^a
Absent	31	55.36	25	44.64	
Present	14	29.17	34	70.83	

^a p-value obtained through the Chi-squared test.

^b p-value obtained through Fisher's exact test.

Table 3
Kuder-Richardson 20 coefficient for the Brazilian version of the Berlin Questionnaire item-total and exclusion of items.

BQ-BR ^a	KR-20 ^b total	Item-total correlation	KR-20 if item excluded
BQ-BR (total)	0.59		
BQ1 (Do you snore?)		0.45	0.52
BQ2 (Snoring loudness)		0.44	0.52
BQ3 (Snoring frequency)		0.54	0.49
BQ4 (Does your snoring bother other people?)		0.36	0.54
BQ5 (How often have your breathing pauses been noticed?)		0.35	0.55
BQ6 (Are you tired after sleeping?)		0.08	0.62
BQ7 (Are you tired during waketime?)		0.20	0.58
BQ8 (Have you ever fallen asleep while driving?)		-0.05	0.65
BQ10 (Do you have high blood pressure?)		0.22	0.58

^a BQ-BR: Brazilian version of the Berlin Questionnaire.

^b KR-20: Kuder-Richardson coefficient.

Table 4
Analysis of the reliability of Categories 1 and 2 of the Brazilian version of the Berlin Questionnaire through Cronbach's alpha coefficient.

Berlin Questionnaire - BR Categories	Questions (Likert type scale)	Cronbach's alpha
1	2, 3 and 5	0.74
2	6, 7 and 9	0.57
	6 and 7	0.74 ^a

^a Question nine was excluded from Category 2 because a large number of participants replied that they did not drive, which implied a non-response to this question.

Table 5
Association between the categories of the Berlin Questionnaire - BR and the apnea and hypopnea index.

Apnea and hypopnea index (AHI)	Berlin Questionnaire - BR		P-value
	low risk, n (%)	high risk, n (%)	
Total, n	45	59	<0.001 ^a
<5	33 (73.3)	7 (11.9)	
5 and <15	8 (17.8)	27 (45.8)	
15 to <30	3 (6.7)	10 (16.9)	
≥30	1 (2.2)	15 (25.4)	

^a p-value obtained through the chi-squared test.

Table 6
Performance of the Brazilian version of the Berlin Questionnaire.

	AHI ^a ≥5 (95%CI ^b)	AHI ≥15 (95%CI)	AHI ≥30 (95%CI)
Sensitivity,%	81.3 (69.54; 89.92)	86.2 (68.34; 96.11)	93.8 (69.77; 99.84)
Specificity,%	82.5 (67.22; 92.66)	54.7 (42.75; 66.21)	50.0 (39.15; 60.85)
PPV ^c ,%	88.1 (78.96; 93.63)	42.4 (35.54; 49.51)	25.4 (21.08; 30.32)
NPV ^d ,%	73.3 (61.82; 82.36)	91.1 (80.13; 96.30)	97.8 (86.70; 99.66)
Positive LR ^e	4.64 (2.36; 9.19)	1.90 (1.43; 2.54)	1.88 (1.47; 2.39)
Negative LR	0.23 (0.13; 0.39)	0.25 (0.10; 0.64)	0.12 (0.02; 0.84)

^a AHI: apnea and hypopnea index.

^b CI: confidence interval.

^c PPV: positive predictive value.

^d NPV: negative predictive value.

^e LR: likelihood ratio.

allows the comparison of different populations [11]. In this study, the cultural adaptation was carried out, and the measurement properties of the Brazilian version of the BQ were investigated. The methodological procedure of cultural adaptation found the semantic-idiomatic, conceptual and cultural equivalence of the Brazilian version of the BQ currently reflects the guarantee of precise content [17]. The familiarity of the committee members with OSA should be highlighted as a relevant point in that process.

The data related to the CVI-I presented an agreement greater than the established minimum rate of 80%, demonstrating that the questionnaire measures of what it proposes to measure. Although the CVI-I of question six indicated valid content, the question was reformulated to make the phrase clearer. It should be emphasized that clarity is an important aspect of any clinical instrument, which should be easily understood by all people [18].

It is recommended in the literature that the pre-final evaluation of the questionnaire, with the goal of cultural adaptation, be done with 30–40 individuals [11]. The Brazilian pre-final version of the BQ-BR was tested with 30 participants in order to analyze possible difficulties and to evaluate its feasibility and acceptability. The instrument had a time of completion of fewer than three minutes, with easy comprehension by the target population, suggesting that this questionnaire is easy to apply.

From the original instrument, only one change was made in question eight since a non-response by 36.7% of the participants because they did not drive was unexpected. This could also be a frequent response by the general population. The score assigned to the “Not Applicable” response was zero.

4.2. Validation of the psychometric properties of the questionnaire

A relevant finding of this study is that 81.3% of the participants who presented a high risk in the assessment of the BQ-BR were identified as having OSA by PSG, according to the AHI criterion ≥ 5 events per hour. In the present study, the prevalence of OSA was 61.6% (AHI ≥ 5 events/hour) similar to that found in other validation studies of the BQ, 54% [8] and 58% [19]. Other authors found an OSA prevalence of 83.2% [20]. The difference in relation to the present study could be explained by not all the population having been referred for the evaluation of respiratory sleep disorders. It should be noted that 63.5% of the subjects were not referred to the sleep disturbances clinic due to suspicion of OSA, but for other reasons. Despite this fact, 61.6% of the entire sample was diagnosed with OSA using PSG.

Regarding the reliability of the measure, the Brazilian version of the BQ presented a KR-20 of 0.59 for the overall score of the instrument. This draws attention to question eight (Have you ever fallen asleep while driving?), which had a negative correlation with the total value. This situation may be related to social desirability, in which individuals respond to what they deem socially correct and not necessarily what they do [21]. With the exclusion of this question, the questionnaire presents the value of 0.65 for the KR-20. However, studies with the application of KR-20 for the validation of the BQ in other populations were not found in the literature. Future studies are necessary to test the Brazilian version of the BQ and to ratify its reliability regarding the homogeneity of the items.

The Brazilian version of the BQ presented evidence of satisfactory internal consistency, with Cronbach's alpha for Category 1 (questions two, three and five) of 0.74 and for Category 2 (questions six, seven and nine) of 0.57, which increased to 0.74 when excluding question nine. Yunus et al. [22], observed a similar result, with a Cronbach's alpha coefficient value of 0.20 for Category 2, which increased to 0.88 with the exclusion of question nine. A probable explanation for this finding may be related to a large number of participants who did not drive and/or who answered with a socially correct and possibly untrue response, that is, they reported not having fallen asleep while driving. The original version for the English culture showed high internal validity of 0.86 and 0.92 (Cronbach's alpha) for Category 1 and 2, respectively [8].

The Brazilian version of the BQ showed evidence of high sensitivity and specificity (AHI ≥ 5) in the criterion validity tested in relation to the AHI obtained through PSG, a “gold standard” measure for the evaluation of OSA. The sensitivity, specificity, PPV and NPV of the BQ-BR, in relation to OSA as evidenced through PSG, show that the questionnaire is capable of identifying participants with a high risk of OSA among those with apnea evidenced through PSG, as well as identify those with low risk. Thus, the high specificity demonstrated by the BQ-BR in identifying individuals at high risk for OSA enables interventions by the health team aimed at early identification and subsequent referral for diagnostic confirmation and treatment. It should be highlighted that, as the severity of the OSA increased (moderate and severe cases), there was an increase in sensitivity and a reduction in specificity. The BQ-BR can be used in screening for OSA, with its clinical confirmation being made with caution and PSG being recommended for the confirmatory diagnosis.

Note that Category 1 of the BQ-BR makes a more accurate measurement possible, demonstrating that the questions on

witnessed snoring and apnea should be evaluated carefully during the interview.

When evaluating the validation process of the BQ in different cultures, it was observed that the authors Netzer et al. [8], Amra et al. [23], Yunus et al. [22], Sharma et al. [24], Saleh et al. [25], and Suksakorn et al. [26], found sensitivity values ranging from 84.5% to 97.0%, being higher than that found in the present study. Chung et al. [27], Hrubos-Strøm et al. [28], Vaz et al. [20], Bouloukaki et al. [29], Khaledi-Paveh et al. [5], and Popević et al. [19], found sensitivity between 37.2% and 77.3%, values lower than that found in the BQ-BR. Note that some studies have validated the BQ in individuals referred to respiratory sleep disorder clinics, which may affect the detection of OSA. Among the studies predicting OSA using the BQ, those that evaluated primary care patients obtained higher sensitivity and specificity values [8,22,24,25], that is, a better ability to discriminate between the truly sick and those who are not sick. In the present study (in spite of being a clinical population) not all the participants were referred for the evaluation of respiratory disorders, which may have contributed to greater sensitivity and specificity.

In the BQ validation studies [20,23,26,29], the results of the sensitivity analyses showed increasing values when using the classification that used the AHI cut points of ≥ 5 ; ≥ 15 , and ≥ 30 events per hour. It should be noted that only the Brazilian and Thai versions [26] of the BQ obtained values greater than 90% in severe patients (ie, with AHI ≥ 30 events per hour). Sensitivity is an important test to verify the accuracy between diagnosis and screening, and the BQ-BR was able to correctly identify those participants with OSA. However, the specificity assessment decreased as the severity of OSA increased.

The AASM recommends that OSA screening be incorporated into routine health assessment [30]. It should be noted that in the Brazilian cultural context PSG is not available in many places, as well as having a high cost. Therefore, the use of a questionnaire widely used in the literature, adapted and validated for the Brazilian cultural context, is valuable for the identification of the person at risk for OSA. Once the patient is identified as high-risk for OSA, PSG is mandatory before any possible intervention, aiming for appropriate treatment of the disease.

The findings of the present study show that the BQ-BR questionnaire is a useful tool in the evaluation of the risk stratification of OSA. Considering the importance of the early diagnosis of OSA, the BQ-BR has shown good sensitivity and can be used as a screening tool for the diagnosis. One limitation that can be highlighted is related to the biases of self-reported measures, especially with regard to social desirability, whereby participants respond according to the social norm [21].

Furthermore, the fact that the study was performed with a clinical population, although the majority of the subjects were not referred for respiratory complaints. Another limitation is related to the heterogeneity of the Brazilian population; it would be important to evaluate the application of the questionnaire in various regions of the country [31].

5. Conclusion

The findings of the present study allow the conclusion that the Brazilian version of the Berlin Questionnaire is an easy-to-understand instrument with reliable and valid measurement properties. The BQ-BR is reliable regarding the homogeneity of the items. The assessment of sensitivity, specificity, PPV, and NPV demonstrated a good ability to detect participants with high and low risk among those with and without OSA identified through PSG. The procedures employed in this study suggest that BQ-BR has criterion validity and its application is appropriate in the Brazilian population.

Acknowledgments

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 38P4842/2018 (CAPES; doctor's scholarship for Carla Renata Silva Andrechuk).

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: <https://doi.org/10.1016/j.sleep.2019.03.022>.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.sleep.2019.03.022>.

References

- [1] Projeto Diretrizes. Associação médica Brasileira (AMB), conselho federal de Medicina (CFM). Apneia Obstrutiva do Sono e Ronco Primário: Diagnóstico 2012. São Paulo: AMB/CFM.
- [2] Young T, Palta M, Dempsey J, et al. The occurrence of sleep-disordered breathing among middle-aged adults. *N Engl J Med* 1993;328(17):1230–5.
- [3] Senaratna V, Perret JL, Lodge CJ, et al. Prevalence of obstructive sleep apnea in the general population: a systematic review. *Sleep Med Rev* 2017;34:70–81.
- [4] Tufik S, Santos-Silva R, Taddei JA, et al. Obstructive sleep apnea syndrome in the Sao Paulo epidemiologic sleep study. *Sleep Med* 2010;11(5):441–6.
- [5] Khaledi-Paveh B, Khazaie H, Nasouri M, et al. Evaluation of Berlin questionnaire validity for sleep apnea risk in sleep clinic populations. *Basic Clin Neurosci* 2016;7(1):43–8.
- [6] Abrishami A, Ali Khajehdehi A, Chung F. A systematic review of screening questionnaires for obstructive sleep apnea. *Can J Anaesth* 2010;57(5):423–38.
- [7] Miller JN, Berger AM. Screening and assessment for obstructive sleep apnea in primary care. *Sleep Med Rev* 2016;22(29):41–51.
- [8] Netzer NC, Stoohs RA, Netzer CM, et al. Using the Berlin Questionnaire to identify patients at risk for the sleep apnea syndrome. *Ann Intern Med* 1999;131(7):485–91.
- [9] Stansbury RC, Strollo P. Clinical manifestations of sleep apnea. *J Thorac Dis* 2015;7(9):298–310.
- [10] Beaton DE, Bombardier C, Guillemin F, et al. Guidelines for the process of cross-cultural adaptation of self-report measures. *SPINE [Internet]* 2000;25(24):3186–319.
- [11] Beaton DE, Bombardier C, Guillemin F, et al. Recommendations for the cross-cultural adaptation of the DASH & quick DASH outcome measures. Institute for Work & Health [Internet]; 2007. p. 01–45.
- [12] Bertolazi AN, Fagundes SC, Hoff LS, et al. Portuguese-language version of the Epworth sleepiness scale: validation for use in Brazil. *Braz J Pulmonol* 2009;35(9):877–83.
- [13] Berry RB, Brooks R, Gamaldo C, et al. AASM scoring manual updates for 2017 (version 2.4). *J Clin Sleep Med* 2017;13(5):665–6.
- [14] Pagano M, Gauvreau K. Princípios de bioestatística. São Paulo: Thompson; 2004.
- [15] Mehta CR, Patel NR. A network algorithm for performing Fisher's exact test in rxc contingency tables. *JASA* 1983;78(382):427–34.
- [16] Kuder GF, Richardson MW. The theory of the estimation of test reliability. *Psychometrika* 1937;2(3):151–60.
- [17] Epstein LJ, Osborne RH, Elsworth GR, et al. Cross-cultural adaptation of the Health Education Impact Questionnaire: experimental study showed expert committee, not back-translation, added value. *J Clin Epidemiol* 2015;68(4):360–9.
- [18] Pasquali L. Princípios de elaboração de escalas psicológicas. *Rev Psiquiatr Clínica* 1998;25(5):206–13.
- [19] Popević MB, Milovanović A, Nagorni-Obradović L, et al. Screening commercial drivers for obstructive sleep apnea: translation and validation of Serbian version of Berlin Questionnaire. *Qual Life Res* 2015;25(2):343–9.
- [20] Vaz AP, Drummond M, Mota PC, et al. Translation of Berlin Questionnaire to Portuguese language and its application in OSA identification in a sleep disordered breathing clinic. *Rev Port Pneumol* 2011;17(2):59–65.
- [21] Polit DF, Yang FM. Measurement and the measurement of change. China: Wolters Kluwer; 2016.
- [22] Yunus A, Seet W, Adam BM, et al. Validation of the Malay version of Berlin questionnaire to identify Malaysian patients for obstructive sleep apnea. *Malays Fam Physician* 2013;8(1):5–11.
- [23] Amra B, Nouranian E, Golshan M, et al. Validation of the Persian version of Berlin sleep questionnaire for diagnosing obstructive sleep apnea. *Int J Prev Med* 2013;4(3):334–9.
- [24] Sharma SK, Vasudev C, Sinha S, et al. Validation of the modified Berlin questionnaire to identify patients at risk for the obstructive sleep apnoea syndrome. *Indian J Med Res* 2006;124(3):281–90.
- [25] Saleh AB, Ahmad MA, Awadalla NJ. Development of Arabic version of Berlin questionnaire to identify obstructive sleep apnea at risk patients. *Ann Thorac Med* 2011;6(4):212–6.
- [26] Suksakorn S, Rattanaumpawan P, Banhiran W, et al. Reliability and validity of a Thai version of the Berlin questionnaire in patients with sleep disordered breathing. *J Med Assoc Thai* 2014;97(3):546–56.
- [27] Chung F, Yegneswaran B, Liao P, et al. Validation of the Berlin questionnaire and American Society of Anesthesiologists checklist as screening tools for obstructive sleep apnea in surgical patients. *Anesthesiology* 2008;108(5):822–30.
- [28] Hrubos-Strøm H, Randby A, Namtvedt SK, et al. A Norwegian population-based study on the risk and prevalence of obstructive sleep apnea. The Akershus sleep apnea Project (ASAP). *J Sleep Res* 2011;20(1pt2):162–70.
- [29] Bouloukaki I, Komninos ID, Mermigkis C, et al. Translation and validation of Berlin questionnaire in primary health care in Greece. *BMC Pulm Med* 2013;13(6).
- [30] Epstein LJ, Kristo D, Strollo Jr PJ, et al. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. *J Clin Sleep Med* 2009;5(3):263–76.
- [31] São-João TM, Rodrigues RCM, Gallani MCB, et al. Cultural adaptation of the Brazilian version of the Godin-Shephard Leisure-time physical activity questionnaire. *Rev Saude Publica* 2013;47(3):479–87.