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Proposing the Clinical Inventory of Sleep Quality☆

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ABSTRACT

Introduction: The aim of the study was to propose the Clinical Inventory of Sleep Quality (CISQ), and compared it with the Pittsburgh sleep quality index (PSQI).
Methods: We studied 400 subjects with the CISQ. Cronbach's *alpha* coefficient was calculated to measure the reliability, and to determine the concurrent validity, a Canonical correlation analysis was performed. At next, we used an exploratory and confirmatory Factorial analysis with Varimax rotation for validity construct calculation.
Results: Cronbach *alpha* coefficient of the scale was significantly strong (α=0.81). Canonic correlation was=0.93, suggesting that data proved that the CISQ and PSQI are measuring identical subject. Confirmatory Factorial analysis model grouped items of the scale in four factors: 1. Daytime symptoms, 2. Nocturnal symptoms, 3. Sleep disordered breathing symptoms, and 4. Sleep-related movement disorders symptoms. We proposed five categories to score CISQ in a range of 0–52 points, as follows: Good quality of sleep, Mild bad sleep quality, Moderate bad sleep quality, Severe bad sleep quality, and Profound bad sleep quality.
Conclusion: CISQ is a promising tool to measure sleep quality and deserve more research to confirm its utility.

1. Introduction

Clinical scales are useful constructs for evaluation of several behaviors for human beings. Quality of life (QoL) is an important issue measured by several scales for mental health of subjects. QoL has been used for measure associated issues related to cancer [1], depression and anxiety disorders [2], disability [3], among others. QoL in sleep has been measured by few instruments [4–6], and there is a need of clinicians for more scales as a tools in their arsenal to search for QoL in patients with sleep disorders. Currently, although there are many scales to measure sleep disorders, some authors had suggested that there is a need to measure sleep disorders in alternative ways [7], because there is no perfect tool that can be used in every circumstance.

Sleep quality (SQ) is a very important measurement to weight QoL, because rest and recovery are among the most important functions of sleep. Several measurements of SQ had been designed. The most frequent worldwide used scale for SQ, is the Pittsburgh sleep quality index (PSQI) [4]. Although PSQI is widely used in sleep medicine, we believe that its use had some limitations, because: (1) The result of the index, only indicates good or poor SQ and does not establish different levels of severity of sleep deficiency, (2) Its rating sometimes is complicated if examiner have no experience with the questionnaire, (3) Although PSQI was translated into the Spanish language and validated with psychiatric patients [8], and in other languages such as French [9], and others, some authors had reported that its internal consistency have no reach the level recommended for individual comparison [10].

For these reasons is important to develop more instruments for SQ measurement in other languages, such as Spanish. Thus, in this study, our objective was to propose and test the Clinical Inventory of Sleep Quality (CISQ), a novel developed instrument to measure SQ, and analyze its psychometric properties.

2. Material and methods

2.1. Subjects

We included 400 subjects divided in two groups: the first group was constructed with citizens from Xalapa City in Veracruz State and from the Clinic of Sleep Disorders in Mexico City, in Mexico, they were the

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individuals from the asymptomatic group (n=258, 166 came from Xalapa, and 92 were healthy volunteers from Mexico City). For the second group, we studied 142 patients from the Clinic of Sleep Disorders with mild-moderate Obstructive sleep apnea-hypopnea syndrome (OSAHS). Exclusion criteria were chronic non-controlled illness, and illiteracy evaluated by the school degree. All subjects were studied by means of a general clinical examination, with CISQ, and PSQI. Mean age of the complete sample was 34.96 years of age, range 18–81 years, 53% were females, and 47% were males. Citizens from Xalapa City and Mexico City had a mean age of 31.94 years of age, 48% were females, and 52% males. Patients from the Clinic of Sleep Disorders had a mean age of 42.42 years of age, 60% were females, and 40% were males. Research protocol was approved by the Ethics and Research Boards of the participant institutions, and the research followed principles of the Declaration of Helsinki. Informed consent was obtained from all individual participants included in the study.

2.2. Clinical Inventory of Sleep Quality (CISQ)

The CISQ consists of twenty questions in Spanish (see Appendix 1 and 2). The scale is self-administered, instructions for its use was given by the specialist in Sleep medicine, the estimated time to fill out the questionnaire was around 10 min. The questionnaire was constructed based on clinical queries used by clinicians and researchers in the Clinic of Sleep Disorders, taking into account the PSQI. From 200 questionnaires answered by college students, we identified the more predictive items for SQ measurement by means of a logistic regression. Afterward, we constructed a pilot questionnaire, and eliminated confused questions, items number one, two and four were joined to measure "Sleep efficiency" (SE), to construct the final version of the CISQ. SE was calculated dividing: number of sleep hours/time in bed×100. Each question had five possible answers, from 0 to 4 points (see Table 1). In the end, we obtained a Total score, where low scores indicate a good SQ, while higher scores indicate a poor SQ.

2.3. Pittsburgh sleep quality index (PSQI)

This questionnaire includes 19 items comprising seven equally weighted components: subjective sleep quality (1 item), sleep latency (2 items), sleep duration (1 item), sleep efficiency (3 items), sleep disturbances (9 items), day-time dysfunction (2 items) and sedative usage (1 item). The seven components were summed to obtain a single global PSQI score, with a possible scale range score from 0 to 21. A global score >5 indicates a poor SQ. The PSQI was used as standard reference of the CISQ usefulness.

2.4. Statistical analysis

We calculated average (x) and Standard deviation (SD) of quantitative variables, and percentages (%) of qualitative variables. We used the Pearson's correlation coefficient to weight strength and direction of correlation of each item of the CISQ. We used the Cronbach's alpha coefficient to determine internal consistency [11], and the Canonic correlation analysis to determine the Concurrent validity of the scale, comparing CISQ with PSQI. We used an Exploratory factorial analysis with a Varimax rotation to weight the items of questionnaire and a final Confirmatory factorial analysis for construct validity. An *alpha* value of $p \leq 0.05$ was selected to accept measurements as significant.

Table 2
Correlation of each questions *vs* the Total score of the Clinical Inventory of Sleep Quality.

Question	r	No. of variables
1. Sleep efficiency	0.52	12
2. How long it takes to sleep?	0.39	9
3. How many hours do you sleep?	0.41	9
4. How many nights do you have insomnia?	0.24	6
5. How many nights do you have difficulties to sleep?	0.59	15
6. How many nights do you wake up once slept?	0.47	13
7. How many nights a week do you wake up once slept?	0.48	14
8. How many nights a week do you have nightmares?	0.28	9
9. What score give you to your sleep quality?	0.64	18
10. How many mornings do you have difficulties for wake-up?	0.46	8
11. How many mornings do you wake up tired?	0.65	15
12. How many days you have the need to sleep at a day?	0.55	10
13. How many days do you have malaise?	0.72	17
14. How do you consider your sleep quality?	0.79	18
15. How many nights do you have restless legs?	0.46	11
16. How many nights do you wake up with cramps?	0.43	12
17. How many nights do you snore?	0.47	12
18. How many nights do you have breathing pauses?	0.41	9
19. Do you have taken a drug for sleep?	0.34	9

3. Results

Mean of the total score of CISQ was 15.78 ± 8.47, in asymptomatic subjects CISQ had a mean total score of 6.34 ± 3.29, PSQI in asymptomatic subjects was 5.66 ± 2.47. Differences between average in the CISQ of sample from Xalapa City-Mexico City and from the Clinic of Sleep Disorders was significant (mean total score of asymptomatic group of citizens from Xalapa City and Mexico City was 12.57 while patients from clinic was 21.60, $t=-11.84$, $p<0.001$). Cronbach alpha coefficient of the scale, was significantly strong (α=0.81). Correlation coefficients of each questions of the questionnaire *vs* the total score of CISQ is showed in Table 2. We eliminated the following questions because had lower values in the Correlation analysis: How long it takes to sleep?, How many nights do you have insomnia?, How many nights a week do you have nightmares?, How many nights a week do you have taken a drug for sleep?, How many hours do you sleep?, What score give you to your sleep quality?, the last couple of questions because they are closely related with sleep efficiency and subjective quality of sleep, respectively. Comparison of CISQ with PSQI by means of Canonic correlation was significantly strong (0.93).

In the Exploratory factorial analysis, we examined the correlation matrix with the Sphericity test of Bartlett and measured sample adequacy by Kaiser-Meyer-Olkin test, which showed a strong correla-

Table 1
Possible answer and scoring of each question of the Clinical Inventory of Sleep Quality (CISQ).

Questions	Score				
	0	1	2	3	4
Sleep efficiency	100–90%	89–80	79–70	69–60	< 60%
How long it takes to sleep?	< 15 min	16–30	31–45	46–60	> 60 min
How many hours do you sleep?	7–8	6 or 9	5 or 10	4 or 11	3 or 12
How many nights do you wake up once slept?	0	1	2	3	4
What score give you to your sleep quality?	10–9	8–7	6–5	4–3	2–1
How do you consider your sleep quality?	Very good	Good	Fair	Bad	Very bad
Questions 5, 6, 8, 9, 11, 12, 13, 14, 16, 17, 18, 19, 20	0 nights/week	1–2 nights/week	3–4 nights/week	5–6 nights/week	≥7 nights/week

Table 3
Weight of factors used in the Maximum likelihood estimation.

	Factor		
	1	2	3
Tiredness	0.798		
Difficulty for wake-up	0.573		
Sleepiness	0.752		
Malaise	0.617	0.454	
Subjective quality	0.595	0.493	
Difficulty for sleep		0.547	
Awakenings at night		0.513	
Awakenings at a week		0.466	
Sleep efficiency		0.637	
Respiratory pauses		0.292	
Snoring		0.305	
Legs restless			0.977
Legs movements			0.630

tion (0.81), needed for factorial analysis. We selected factors using the Maximum likelihood estimation, and supported in this measurement, we chose three factors for analysis. Factor one, explains 32% of variance, factor two explains 14%, and factor three explains 9%. In overall, variance explained by the three factors was 56%.

The next step was to identify variables of each question for each factor. We used a Varimax rotation to identify each variable in a particular factor. Factorial weights of each item are presented in Table 3 grouped in the three factors, as follows: 1. Daytime symptoms, 2. Nocturnal symptoms, 3. Respiratory alterations. We built a Model of covariance structures identifying: number of common factors, number of observed variables, links between common factors, relationships among observed variables and common factors, from each factor and observed variables, and from each factor to the others. We designed a diagram of sequences with the relationship of causality among factors and observed variables. We calculated the Maximum likelihood estimation and identified violator variables with coefficients near or over 1.0. Because we have several infringing variables, we proposed a new model for the Confirmatory factorial analysis. The new model was grouped in four factors: 1. Daytime symptoms, 2. Nocturnal symptoms, 3. Sleep disordered breathing symptoms (SDBS), and 4. Sleep related movement disorders symptoms (SRMDS). Table 4 shows model estimation. As can be observed in table, there are no infractions, all variances are positive, standardized coefficients are < 1.00, and standard errors are low.

We calculated measures of Goodness of fit of the Confirmatory factorial analysis, and showed in Table 5. We observed good scores in

Table 4
Factorial weights of each item.

Variables	Indicators	Estimates	SE	Z score	*p*	Variance
Daytime symptoms	X_1	1.00				0.42
	X_2	0.74	0.06	11.63	< .001	0.17
	X_3	0.88	0.06	14.18	< .001	0.87
	X_4	0.62	0.05	11.43	< .001	0.56
	X_5	0.40	0.04	9.57	< .001	0.32
Nocturnal symptoms	X_6	1.00				0.79
	X_7	0.83	0.08	9.317	< .001	1.00
	X_8	0.63	0.06	9.549	< .001	0.54
	X_9	0.92	0.09	9.560	< .001	1.12
	X_4	0.50	0.07	6.998	< .001	
	X_5	0.62	0.06	9.547	< .001	
SDB symptoms	X_{10}	1.00				0.46
	X_{11}	0.86	0.14	6.047	< .001	1.27
SRMD symptoms	X_{12}	1.00				0.18
	X_{13}	0.64	0.09	6.811	< .001	0.29

SE=Standard error. p=probability. SDB=Sleep disordered breathing. SRMD=Sleep related movement disorders.

Table 5
Measures of Goodness of fit.

	n = 400
Goodness of fit index	0.95
Crossed validation index	0.45
Measures of incremental adjust	
Adjusted Goodness of fit index	0.93
Tucker–Lewis index	0.95
Index of non-normed fit	0.95
Index of normed fit	0.93
Measures of parsimony adjust	
Normed fit of parsimony index	0.68
Akaike criteria of information	14635.14
Comparative fit index	0.96
Incremental fit index	0.96
Relative fit index	0.90

Table 6
Measurement of Construct reliability and Variance of model adjusted.

Construct	Reliability	Variance
Daytime symptoms	0.82	0.48
Insomnia effects	0.76	0.36
Respiratorios alterations	0.72	0.57
Movements alterations	0.76	0.62

all measures, which confirm usefulness of the CISQ. We obtained the Construct reliability, and Variance measurements presented in Table 6 and Fig. 1. The four constructs are over the suggested reliability level (0.70), and near of suggested variance level (0.50). In base of our results, we proposed a 13 items questionnaire, divided in five classification categories, in a range of 0–52 points, and excluding questions that no contributed to analysis, as follows: Good quality of sleep=0–10, Mild bad sleep quality=11–15, Moderate bad sleep quality=16–22, Severe bad sleep quality=23–35, and Profound bad sleep quality=36–52.

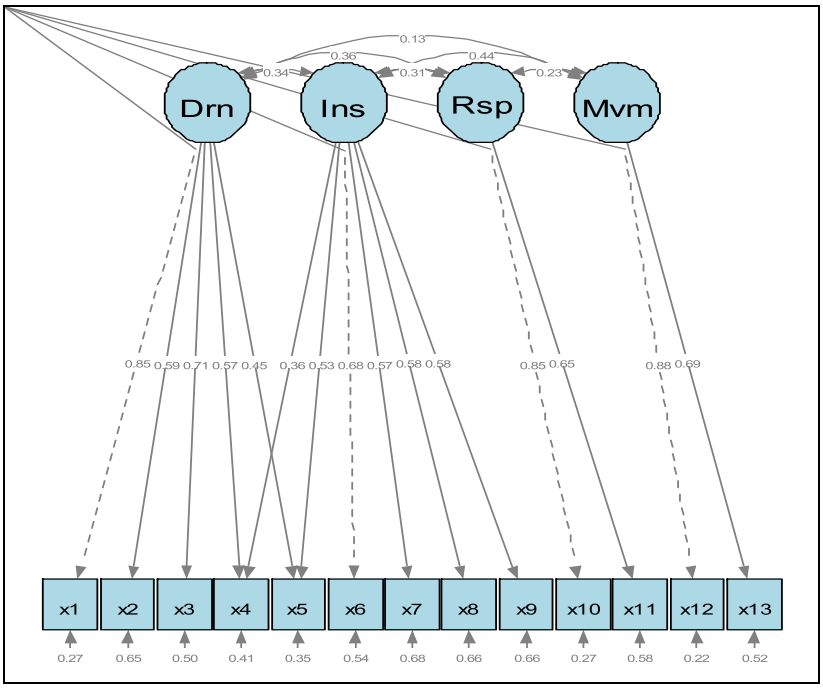
4. Discussion

4.1. Main findings

Our main contribution was to propose and validate the CISQ as a new tool. The questionnaire presents several advantages for Spanish speaking population due is easier to use, to score, and interpret, because has few items, allows a well defined cut-point, and provide severity levels that defined bad SQ. CISQ proved to be a consistent tests, because had a high Cronbach alpha score. Concurrent validity found by means of Canonic correlation was high, which indicates that CISQ has a good validity and its content really measure SQ. We proposed five levels for interpretation the total score: good SQ, bad SQ of mild intensity, bad SQ of moderate intensity, bad SQ of severe intensity, and bad SQ of profound intensity.

4.2. Clinical utility

Sleep medicine is an emergent medical speciality in several Spanish-speaking countries. Sleep alterations have a high prevalence in these developing countries [12], thus, these populations are in need for alternative screening and diagnostic tools for sleep alterations [13]. None questionnaire or subjective scale is free from biases, thus we should always look for improved tools. There are some articles providing caveats and drawbacks on the use of PSQI, some problems with PSQI are based and argued solely on subjectivity of opinions and perceptions of the responders [10]. The questionnaire proposed here, includes four important areas of sleep problems, such as: daytime symptoms, nocturnal symptoms, sleep breathing disorders, and sleep



Drn = Daytime symptoms. Ins = Insomnia effects. Rsp = Respiratory alterations. Mvm = Movements alterations.

Fig. 1. Standardized model of multi-factorial analysis of the Clinical Inventory of Sleep Quality.

related movement alterations. Thus, we believe that CISQ had a broad space to fill and some advantages over PSQI.

4.3. Comparison with other studies

Mollayeva et al. reviewed the properties of the PSQI, searching for its potential as a screening tool for sleep dysfunction in non-clinical and clinical samples, authors reviewed several studies: 22 examined construct validity, 19 known-group validity, 15 internal consistency, and three test-retest reliability. Internal consistency, based on Cronbach's alpha, was good; discrepancies were observed in factor analytic studies; in non-clinical and clinical samples with known differences in sleep quality, the PSQI global scores and all subscale scores, with the exception of sleep disturbance, which differed significantly. The best evidence for the PSQI showed strong reliability and validity, and moderate structural validity in a variety of samples, suggesting the tool can be improved [10].

There are no other studies in search of CISQ usefulness, however, validation of PSQI in Spanish had deserved some studies. In example, Escobar-Cordova and Eslava-Schmalbach validated PSQI use in Colombia, they observed that evaluation of internal consistency was significant (Cronbach's alpha=0.78), there were different scores between subjects that mentioned some subjective sleep disturbance, and between them in which qualify were "so bad" or not, in their SQ, and among those that were consuming or not, habitually hypnotics and between those that referred conciliation insomnia or not. There were clinical differences in PSQI scores between adults older and younger. Authors observed no differences by gender [14].

Jimenez-Genchi et al. studied eighty seven psychiatric patients without treatment and 48 control subjects, who underwent psychiatric structured assessment and completed the PSQI. There were no significant differences between psychiatric patients and control subjects on age and gender. The PSQI displayed a satisfactory Reliability coefficient (0.78) and components of total score correlations were all significant (0.53–0.77). The PSQI showed two main factors: sleep duration and sleep quality. Patients obtained significantly higher scores than controls, in both the global and the component scores, with the exception of sleep duration. The PSQI scores were not significantly different between males and females and were not associated with age [8].

Thus, in both above quoted studies, validation of the use of PSQI in Spanish speaking populations was carried-out. Other studies had validates use of PSQI in QoL for sleep apnea [15], and sleep quality in fibromyalgia [16] as an example of the need of SQ measurements. At last, despite the article has been written in English, CISQ was developed and used in Spanish populations.

4.4. Limitations of the study

The number of studied patients in short, the observation had a cross-sectional design instead a prospective follow-up, however the observation is valious and conclusions are valid for the target population. On the other hand, it is important to state clearly that the questionnaire is validated only for its use on Spanish speaking patients. Future observations overcome these limitations.

5. Conclusions

Comparison of CISQ with PSQI by means of Canonic correlation was significantly strong, this proves us that the two measurement procedures are measuring identical subject construct. CISQ is a promising tool to measure sleep quality and deserve more research to confirm its utility.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.slsci.2016.10.002.

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