

The Pittsburgh Sleep Quality Index:

Validity and factor structure in young people

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Abstract

The Pittsburgh Sleep Quality Index (PSQI) is a widely used measure of sleep quality in adolescents, but information regarding its psychometric strengths and weaknesses in this population is limited. In particular, questions remain regarding whether it measures one or two sleep quality domains. The aims of the present study were to (1) adapt the PSQI for use in adolescents and young adults and (2) evaluate the psychometric properties of the adapted measure in this population. The PSQI was slightly modified to make it more appropriate for use in youth populations, and translated into Spanish for administration to the sample population available to the study investigators. It was then administered with validity criterion measures to a community-based sample of Spanish adolescents and young adults (AYA) between 14 and 24 years old (N = 216). The results indicated that the questionnaire (AYA-PSQI-S) assesses a single factor. The total score evidenced good convergent and divergent validity, and moderate reliability (Cronbach's alpha = 0.72). The AYA-PSQI-S demonstrates adequate psychometric properties for use in clinical trials involving adolescents and young adults. Additional research to further evaluate the reliability and validity of the measure for use in clinical settings is warranted.

Key Words: PSQI, psychometric properties, confirmatory factor analysis, sleep quality, assessment.

The Pittsburgh Sleep Quality Index (PSQI) (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) has been used extensively in the evaluation of sleep quality for nearly twenty-five years. The PSQI consists of 24 items, although the primary PSQI sleep quality score is calculated using only the first 19 items. The PSQI has demonstrated adequate reliability (Cronbach's alpha = 0.83, test-retest reliability $r = 0.85$) and evidence indicates that it measures a single factor in adults (Buysse et al., 1989). Moreover, the PSQI has been found to be valid and reliable as a measure of sleep quality in samples of patients with anxiety disorders (Bush, Armento, & Weiss, 2012) and cancer (Mystakidou et al., 2007). It has also been found to be valid and reliable in bilingual English and Spanish speaking populations (Tomfohr, Schweizer, Dimsdale, & Loreda, 2013).

Although most of the research supporting the validity and reliability of the PSQI scores has been performed in studies using adult samples, the measure has also been used in a number of studies with children as young as 5 years old and with adolescents with a variety of health problems (e.g., Fauroux et al., 2012; Zhang et al., 2012). However, the questionnaire has not been administered uniformly in these studies. For example, some studies have used the adult version of the scale without any adaptation (e.g., Brand et al., 2011; Fauroux et al., 2012; Lund, Reider, Whiting, & Prichard, 2010; Zhou et al., 2012), despite the fact that one of the items refers to an activity (driving) not appropriate for children. When investigators have modified the PSQI for use in research with youth samples, the changes made are inconsistent and unique to each study. They sometimes involve minor changes in the wording of some items (e.g., Prehn-Kristensen et al., 2013). Other times the changes have involved the elimination of one or more items (e.g., Bajoghli, Alipouri, Holsboer-

Trachsler, & Brand, 2013). Thus, at this point, there is not yet a standard youth version of the PSQI that can be used by investigators across research studies.

In addition, few studies have examined the psychometric properties of the PSQI in samples of young people. Two studies have reported on its internal consistency, with very similar adequate Cronbach's alphas (0.73 and 0.74) in the youth samples examined (Lund et al., 2010; Siu, Chan, Wong, & Wong, 2012). To our knowledge, only one study (Benhayon et al., 2013) has examined the factor structure of the PSQI in young people. This study found the most support for a two-factor structure. However, this finding is inconsistent with what would be predicted based on the findings from the majority of research with adults. It is possible that the low sample size used in this study (N = 96) may explain the inconsistent finding.

The aim of this study was to address the need for additional research evaluating the psychometric properties of the PSQI for use in adolescents and young adults. In particular, we were interested in (1) determining whether the PSQI would evidence a 1- or 2-factor structure in a sample of youths and (2) evaluating the reliability and validity of the scale score(s) of the measure (American Educational Research Association, 2014). If reliable, we hypothesized that the scale score(s) that emerged would evidence at least adequate internal consistency (Cronbach's alpha; Cronbach, 1990), and test-retest stability coefficients of 0.70 or greater. Furthermore, if valid, we anticipated that the scores on the adapted PSQI would be significantly and positively associated with fatigue, given that previous studies have shown that poor sleep quality is associated with fatigue (e.g., Gedaly-Duff, Lee, Nail, Nicholson, & Kyle, 2006; Moldofsky, 2001). We also anticipated that the

adapted PSQI would be negatively associated with positive mood, consistent with research showing that mood is influenced by and associated with sleep quality (Busch et al., 2012; Lund et al., 2010; O'Brien et al., 2010).

Methods

Participants

Participants were recruited using a convenience sampling technique. Adolescents and young adults were contacted through patient associations, poster advertisements placed on a university campus (*Universitat Rovira i Virgili*), our research group webpage, and through two local schools. We determined *a priori* that the minimum sample size needed to have adequate power to perform the planned analyses was $N = 200$ (Kline, 2005). Study inclusion criteria were (1) being between 14 and 24 years old and (2) having an ability to speak and read Spanish. The final sample consisted of 216 youths aged 14-24 years (mean age = 17.12; $SD = 3.05$) of whom 83 were boys or young men (38%) and 133 were girls or young women (62%).

Measures

Sleep quality. A slightly adapted and then translated version of the PSQI (AYA-PSQI-S) was used in this study. Most of the PSQI items are appropriate for use in an adolescent population. However, because Spanish adolescents cannot drive until the age of 18, item #8 (i.e., "During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?") was replaced with text referring to studying, which is a common activity among adolescents that can also be associated with somnolence. This change was made in order to reduce construct-irrelevant variance. The PSQI used in this study is otherwise identical to the original.

At the time of data collection, there were three adult versions of the PSQI that had been translated into Spanish: Mexican Spanish (Jiménez-Genchi, 2008), Colombian Spanish (Escobar-Córdoba & Eslava-Schmalbach, 2005), and the Spanish of Spain (Royuela & Macías, 1997). However, all three of these translations used old-fashioned expressions and complex language. Therefore, after reviewing the language used in these versions, we decided to perform a new translation. For the translation, we used a back-translation procedure described by Miró (1997) consisting of three steps. First, we performed an initial translation of the instrument into contemporary Spanish. Next we gave the newly translated version to a native English speaker from our University translation service and asked this individual to perform a back-translation. Finally, we asked a second translator to compare the back-translated items with the original, looking specifically for divergences in the connotation and denotation of the items. No divergences were found in this step. We created both a paper-and-pencil and an electronic version of the final version of the measure for use in the current study. A copy of the measure (AYA-PSQI-S, for adolescents and young adults PSQI-Spanish version) is available from the corresponding author.

Validity criterion. The criterion validity of the PSQI was assessed using measures of two domains: fatigue and global mood. Both of these were assessed using 0 -10 numerical rating scales, with 0 = “No fatigue” or “Worst imaginable mood” and 10 = “Worst imaginable fatigue”, or “Best imaginable mood”, respectively. Such scales are commonly used to assess the domains of fatigue (Dures et al., 2013; Minnock, Kirwan, & Bresnihan, 2009) and mood (Huber et al., 2007; Knotkova, Crawford Clark, Mokrejs, Padour, & Kuhl, 2004)

in research, and have demonstrated validity by their responsiveness to treatment effects, as well as by their significant associations with measures of other related constructs.

Procedures

Potential participants were invited to participate via (1) e-mails sent to patient associations and schools or (2) by in-person presentation to two local schools. Twenty-seven associations were contacted and eight agreed to assist with data collection. The AYA-PSQI-S and the 0-10 measures of the validity criteria were sent to the participants via e-mail with a link and password access, or presented to other participants in a paper-and-pencil version. Participants were instructed to complete the questionnaire on their own, without any assistance from their parents or teachers. The administration took place during the school year to avoid the potential holiday interference with sleep habits or usual sleep quality.

The average time to respond to the study measures was 15 minutes. A total 367 participants agreed to participate and provided at least some data. However, 117 (32%) of these did not provide complete data, and were therefore excluded from further analyses. In addition, 34 (9%) individuals who had agreed to participate and who provided data were either under or over the targeted age. Thus, complete data from the initial assessment were available from 216 participants: 116 (54%) provided information online and 100 (46%) completed the paper-and-pencil version of the questionnaires.

Six weeks later, a time period that has been recommended as ideal for retest in order to avoid memory effects and maturation effects (see Ferrando, 2002), an invitation to complete the AYA-PSQI-S was sent to all participants via

e-mail. However, only 33 of 216 participants (15%) responded to this invitation, and nine of these were excluded from the analysis because they reported significant changes in their health or mental status in the interim that could potentially impact sleep quality. These changes included: a calf injury, trigeminal neuralgia, sudden dizziness, severe worries, recurring nightmares or exam anxiety.

Data Analyses

We first computed seven PSQI “sleep components” from the 19 items used to compute the total score, and used these component scores as the “items” in the planned analyses. Next, we tested the suitability of the data for factor analyses using the Kaiser-Meyer-Olkin test (KMO) (Kaiser, 1970) and Bartlett’s statistic (Bartlett, 1950), and examined the skewness and kurtosis of the items. We then performed a Confirmatory Factor Analysis (CFA) of the seven AYA-PSQI-S component scores to evaluate their factor structure. Because skewness was greater than 1 for some of the items, the method selected for factor extraction was the Maximum Likelihood Mean adjusted (MLM; Lawley & Maxwell, 1962) because it does not require that the items have normal distributions. We tested and compared both a one-factor model, which has been supported by previous research in adults (Bush et al., 2012; Buysse et al., 1989; Royuela & Macías, 1997), and a two-factor model which was suggested by a single study in an adolescent sample (Benhayon et al., 2013). Next, we evaluated the scale score that emerged from the CFA by computing both internal consistency (Cronbach’s alpha) and test-retest stability (Pearson correlation) coefficients. Finally, we evaluated the criterion validity of the AYA -

PSQI-S score by computing Pearson correlation coefficients between this score and the 0-10 measures of fatigue and mood.

Results

Factor structure of the Peds-PSQI-S

The AYA-PSQI-S items showed good fit indexes for factor analysis: KMO = 0.77, Bartlett = 326.7 (df = 21; $p < 0.001$). The one-factor model showed a good adjustment in the CFA, consistent with the results of studies with adult samples (Bush et al., 2012; Buysse et al., 1989; Royuela & Macías, 1997): Chi-square ($\chi^2 = 31.08$, $p < 0.05$), Comparative Fit Index (CFI = 0.91) and Root-Mean-Square Error of Approximation (RMSEA = 0.08). All of the component scores but one had adequate communality loadings (range, 0.42 to 0.66). Component 6 (sleep medication use), however, evidenced an inadequately low communality loading (0.24) and high skewness (2.86), so it was removed from consideration in all subsequent analyses. With component 6 removed, the adjustment indexes did not change substantially: Chi-square ($\chi^2 = 26.07$, $p < 0.01$), Comparative Fit Index (CFI = 0.91) and Root-Mean-Square Error of Approximation (RMSEA = 0.09). All of the components have factor loadings > 0.40 in the one-factor model (see Table 1), i.e.: component 1 (0.421), component 2 (0.620), component 3 (0.656), component 4 (0.567), component 5 component (0.606), component 7 (0.485).

The two-factor model showed a similar Chi-square value ($\chi^2 = 26.48$, $p < 0.01$) as the one-factor model, as evidenced by the Satorra-Bentler scaled Chi-squared difference test (Satorra & Bentler, 1999) ($\chi^2 = 0.532$, $p = \text{NS}$). However, the two-factor model showed a slightly worse Comparative Fit Index (CFI = 0.90) and a slightly worse Root-Mean-Square Error of Approximation (RMSEA

= 0.103), relative to the one-factor model. Moreover, the factors that emerged from the two-factor model analysis had a very strong correlation with each other ($r = 0.93$), suggesting that both assess the same domain. As a result of the CFAs, we determined that the AYA-PSQI-S components (minus component 6) assess a single global factor.

Reliability and criterion validity of the AYA-PSQI-S scores

Scores on the AYA-PSQI-S total score evidenced adequate internal consistency (Cronbach's alpha = 0.72) and good test-retest stability over a 6-week period ($r = 0.81$, $p < 0.001$). The total score also evidenced moderate and significant correlations with mood ($r = -0.35$; $p < 0.001$) and fatigue ($r = 0.42$; $p < 0.001$).

Discussion

This study reports on the psychometric properties of a *slightly modified version* of the Pittsburgh Sleep Quality Index for use in adolescents and young adults (AYA-PSQI-S). In our sample, we found that the AYA-PSQI-S measures a single domain, as evidenced by its single-factor structure; a finding consistent with a number of previous studies in adults, including the original scale development work by Buysse and colleagues (e.g., Bush et al., 2012; Buysse et al., 1989; Royuela & Macías, 1997). This domain can be viewed as representing "general poor sleep quality," and includes both quantitative (sleep latency, sleep duration, sleep efficiency) and qualitative (sleep disturbances, daytime dysfunction) aspects.

Some other studies have found two (Benhayon et al., 2013; Jiménez-Genchi, 2008; Nicassio et al., 2014) or even three-factor structures (Aloba, Adewuya, Ola, & Mapayi, 2007; Cole et al., 2006; Magee, Caputi, Iverson, &

Huang, 2008) for the PSQI in adult samples. These studies, however, used different populations (e.g., the elderly; Cole et al., 2006) or had relatively small sample sizes (Benhayon et al., 2013; Jiménez-Genchi, 2008), which can limit the generalizability and reliability of the findings. Moreover, a number of these studies used the Principal Components Analysis (PCA) factor analysis approach rather than CFA, and it has been shown that PCA tends to result in more factors than are truly represented in a data set (Anguiano-Carrasco, 2010). Based on the available research and the current findings, our view is that the PSQI, and certainly the AYA-PSQI-S in young people, assesses a single factor.

We found in our initial item analysis that the PSQI component 6 (sleep medication use) did not perform well. We therefore removed this component from our analyses. This finding is consistent with previous research in adolescents and adults (Benhayon et al., 2013; Tomfohr, Schweizer, Dimsdale, & Lored, 2013; Zhou et al., 2012), and suggests that the measure's psychometric properties can be improved by not including this component in the total scale score. However, information regarding sleep medication might be important for making clinical decisions, so we are not suggesting that the question regarding medication use not be asked when administering the measure; only that the response to this item not be used when computing the total sleep quality score.

Consistent with the findings from the two previous studies reporting on the reliability of the PSQI scores in youths, the reliability of the AYA-PSQI-S scores in our sample of participants was somewhat lower than reported in adult populations (Lund et al., 2010; Siu et al., 2012). Still, we found the measure's

internal consistency was adequate, indicating that the scores obtained with the AYA-PSQI-S can be used in clinical trials with large samples of adolescents and young adults. More research is needed to determine if the scores obtained with the AYA-PSQI-S are adequately reliable for use with young populations in clinical practice (i.e., for making clinical decisions), or if it would be necessary to modify the AYA-PSQI-S to increase its reliability, or even to develop a new measure of sleep quality for use in this population in clinical settings.

Moderate associations were found between the scores obtained with the AYA-PSQI-S and the ratings of both fatigue and mood. Specifically, the AYA-PSQI-S total score was associated positively with fatigue and negatively with mood. These findings are consistent with our hypotheses, and provide evidence for the criterion validity of the measure. While additional support for the validity of the AYA-PSQI-S total score could have been obtained had we administered other measures of sleep quality or measures of domains hypothesized to be associated with sleep quality, our findings are consistent with the AYA-PSQI-S being a valid measure of sleep quality.

The study has a number of limitations that should be considered when interpreting the results. First, the study data were collected in two ways: internet-based and pencil-and-paper forms. It is possible that the findings might have differed somewhat had all data been collected using the same strategy. However, research suggests that electronic versions of health-related questionnaires yield scores that are similar to paper-and-pencil versions (Mangunkusumo et al., 2005; Vereecken & Maes, 2006), so we do not think that the use of two assessment strategies had a strong biasing influence on the findings. Second, to our knowledge this is only the second study to investigate

the factor structure of the PSQI (or in our case, the AYA-PSQI-S) in a sample of young people. Although our findings supported a single factor, they were not consistent with a previous study which supported a two-factor structure for the PSQI items in a sample of youths. Additional research examining the factor structure of the PSQI would be useful to help confirm the factor structure of the PSQI in young people. Finally, we used single-item numerical rating scales to assess the validity criterion of mood and fatigue. Although this procedure has been shown to provide valid and reliable information (e.g., Dures et al., 2013; Huber et al., 2007), future research might profit from the use of multi-item questionnaires to further explore the validity of the AYA-PSQI-S.

Despite the study's limitations, the findings provide important additional information regarding the validity and reliability of scores obtained using PSQI to assess sleep quality in adolescents and young adults. This information is relevant to making informed decisions regarding the use of the PSQI in youths in research settings. Additional research will help determine the generalizability of our findings, and determine if revisions to the PSQI are needed for the measure to be used in clinical settings, or if perhaps a new measure of sleep quality in youths for clinical applications needs to be developed.

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