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Psychometric Properties of the Pittsburgh Sleep Quality Index (PSQI) in a Cohort of Peruvian Pregnant Women

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Study Objectives: We sought to evaluate the construct validity and factor structure of the Spanish-language version of the Pittsburgh Sleep Quality Index (PSQI) among pregnant Peruvian women.

Methods: A cohort of 642 women were interviewed at ≤ 16 weeks of gestation. During interview, we ascertained information about lifestyles, demographics, sleep characteristics, and mood symptoms. Stress induced sleep disturbance, depressive symptoms, and anxiety symptoms were evaluated using the Ford Insomnia Response to Stress Test (FIRST), Patient Health Questionnaire-9 (PHQ-9), and Generalized Anxiety Disorder-7 (GAD-7) assessment scales, respectively. Consistency indices, exploratory and confirmatory factor analyses, correlations, and logistic regressions were used.

Results: Both exploratory and confirmatory factor analyses indicated a three-factor solution: sleep quality, sleep efficiency, and sleep medication. We observed significantly positive correlations of the PSQI with the FIRST (0.42), the PHQ-9 (0.49), and the GAD-7 (0.46). Poor sleepers (PSQI global score > 5) had significantly increased odds of experiencing stress-induced sleep disturbance (odds ratio, OR = 3.57; 95% CI: 2.40, 5.31), depression (OR = 5.48; 95% CI: 3.58, 8.37), and generalized anxiety disorder (OR = 4.57; 95% CI: 3.08, 6.76).

Conclusions: The Spanish-language version of the PSQI instrument was found to have good construct validity among pregnant Peruvian women. Consistent with some other studies, the PSQI was found to have a three-factor structure. Further assessment and validation studies are needed to determine whether the three, factor-specific scoring of the PSQI is favored over the PSQI global score in diverse populations.

Keywords: Pittsburgh Sleep Quality Index, psychometric properties, Peru, pregnant women, sleep

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Among pregnant women, pregnancy-associated physiological and hormonal changes are known to contribute to increased prevalence and severity of sleep complaints and disorders.[1,2] Sleep complaints and disorders experienced in early pregnancy have been linked to hyperemesis, cesarean delivery, preterm birth, gestational diabetes mellitus, fetal growth restriction, and preeclampsia.[2–5] Of note, an emerging literature has suggested that sleep disorders and poor sleep quality predict an increased risk of mood disorders including depressive symptomatology in late pregnancy.[6,7] However, despite these observations and their clinical implications, relatively little has been done to design and implement clinical protocols that may be used to reliably and validly assess sleep efficiency and night and daytime disturbance among pregnant women.

One widely used self-reported measure of sleep quality, the Pittsburgh Sleep Quality Index (PSQI), has been established as a valid scale with acceptable psychometric properties when used among men and non-pregnant women in diverse global settings.[8–18] Though increasingly being used among pregnant women,[1,7,19] the psychometric properties of the PSQI has not been adequately assessed in this population. We are aware of only two published studies have evaluated the psychometric properties of the PSQI among pregnant women.[1,7] Jomeen et al., in their study of 148 pregnant women assessed at 14 weeks of gestation, reported that the PSQI had good internal consistency, construct validity, and divergent validity.[1] Furthermore, among this cohort of British women, the authors reported that early pregnancy poor sleep quality as assessed using the global PSQI score was statistically significantly associated with depressive symptoms.[1] In a subsequent study conducted among

BRIEF SUMMARY

Current Knowledge/Study Rationale: The Pittsburgh Sleep Quality Index (PSQI) has been established as a valid scale with acceptable psychometric properties when used in men and non-pregnant women in diverse global settings. However, few studies have assessed the reliability and validity of this scale in pregnant women, among whom disturbed sleep and poor sleep quality are common complaints; even fewer have assessed the psychometric properties of the scale when used among women from low- and middle-income countries, where sleep, mood, and anxiety disorders are highly prevalent and comorbid.

Study Impact: This is the first study that evaluates the construct validity and factor structure of the Spanish-language version of the PSQI among low-income, pregnant Peruvian women. Our results indicate that the Spanish-language version of the PSQI is appropriate for clinical research use with good construct validity for pregnant women during the first trimester of pregnancy; additional research designed to more thoroughly assess the comparative effectiveness of using a three, factor-specific scoring of the PSQI versus the generally favored single global score of PSQI is indicated.

252 Australian pregnant women, Skouteris et al. reported that the PSQI, when administered in the second half of pregnancy, showed good reliability and construct validity.[7] Moreover, the authors reported that the PSQI prospectively predicted increases in depressive symptomatology.

Given the scarcity of studies concerning the psychometric properties of the PSQI when used among pregnant women, and given that prior studies have shown that sleep, mood, and anxiety disorders are highly prevalent among low-income pregnant women in Lima, Peru,[20,21] we sought to evaluate the psychometric properties of the Spanish-language version of the PSQI among pregnant Peruvian women during early pregnancy. We also assessed the relation of maternal early pregnancy sleep quality with measures of stress-induced sleep disturbance, and depressive and anxiety symptoms.

METHODS

Study Population

This cross-sectional study was a part of the Pregnancy Outcomes, Maternal and Infant Study (PrOMIS) Cohort, a prospective cohort study of pregnant women enrolled in prenatal care clinics at the Instituto Nacional Materno Perinatal (INMP) in Lima, Peru. The INMP, under the aegis of the Peruvian Ministry of Health, is the primary referral hospital for maternal and perinatal care. From October 2013 to February 2014, women who started their first prenatal care visit in the INMP were recruited. The study population included pregnant women who were 18–49 years with a gestational age ≤ 16 weeks and who spoke and understood Spanish. Informed consent was provided by all participants. The institutional review boards from the INMP and the Human Research Administration Office at Harvard T.H. Chan School of Public Health approved all procedures used in this study.

Data Collection

In a private setting, participants were interviewed by trained research personnel using a structured questionnaire. Information regarding maternal sociodemographics, lifestyle characteristics, medical and reproductive history, childhood abuse and intimate partner violence, symptoms of depression and anxiety, and sleep problems was collected. Of the 911 participants approached, 652 participants completed the interview. With 10 participants excluded because of missing information on the PSQI, 642 participants remained in the present analysis.

Measures

Pittsburgh Sleep Quality Index (PSQI)

The PSQI is a 19-item, self-rated questionnaire designed to measure sleep quality and disturbance over the past month in clinical populations.[17] The 19 items are grouped into 7 components, including (1) sleep duration, (2) sleep disturbance, (3) sleep latency, (4) daytime dysfunction due to sleepiness, (5) sleep efficiency, (6) overall sleep quality, and (7) sleep medication use. Each of the sleep components yields a score ranging from 0 to 3, with 3 indicating the greatest dysfunction. The sleep component scores are summed to yield a total score ranging from 0 to 21 with the higher total score (referred to as global score) indicating worse sleep quality. In distinguishing good and poor sleepers, a global PSQI score > 5 yields a sensitivity of 89.6% and a specificity of 86.5%.[17]

Ford Insomnia Response to Stress Test (FIRST)

The FIRST is a highly reliable (test-retest reliability = 0.92) questionnaire designed to measure vulnerability to sleep disturbance in response to commonly experienced stressful situations.[22] The FIRST includes 9 items asking about the likelihood of having sleep disruption due to specific stressful situations and more broadly described periods of stress occurring during the day or evening. The 9 situations are: (1) before an important meeting the next day, (2) after a stressful experience during the day, (3) after a stressful experience in the evening, (4) after getting bad news during the day, (5) after watching a frightening movie or TV show, (6) after having a bad day at work, (7) after an argument, (8) before having to speak in public, and (9) before going on vacation the next day. Participants are asked to rate how likely for them to have difficulty in sleeping when they recently experience these stressful situations. Response categories are "not likely," "somewhat likely," "moderately likely," and "very likely," scored as 1, 2, 3, and 4, respectively. The total score ranges from 9 to 36. High scores on the FIRST indicate greater vulnerability to sleep disruption. Consistent with prior studies, we used the median score (12) to define high and low FIRST score groups.[22,23]

Patient Health Questionnaire-9 (PHQ-9)

The PHQ-9 is a 9-item self-reported, diagnostic and severity measure for current (in the prior 14 days) depression using criteria from the *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (DSM-IV).[24,25] The 9 items include: (1) anhedonia, (2) depressed mood, (3) insomnia or hypersomnia, (4) fatigue or loss of energy, (5) appetite disturbance, (6) guilt or worthlessness, (7) diminished ability to think or concentrate, (8) psychomotor agitation or retardation, and (9) suicidal thoughts. Scores for each item range from 0 ("not at all") to 3 ("nearly every day"). The PHQ-9 total score is the sum of scores for the 9 items for each participant and ranges from 0 to 27. Among patients from general care clinics and obstetrics-gynecology clinics, a score ≥ 10 is associated with a sensitivity of 88% and a specificity of 88% in diagnosing major depressive disorder (MDD).[24] The Spanish-language version of the PHQ-9 was shown to work well in pregnant women with good reliability and construct validity.[20,26] In the current study, the presence of depression was defined as the PHQ-9 score ≥ 10.

Generalized Anxiety Disorder-7 (GAD-7)

The GAD-7 is a 7-item questionnaire developed to identify probable cases of generalized anxiety disorder (GAD) and measure the severity of GAD symptoms.[27] The GAD-7 items include: (1) nervousness, (2) inability to stop worrying, (3) excessive worry, (4) restlessness, (5) difficulty in relaxing, (6) easy irritation, and (7) fear of something awful happening. The GAD-7 asks participants to rate how often they have been bothered by each of these 7 core symptoms over the past 2 weeks. Scores for each item range from 0 ("not at all") to 3 ("nearly every day"). The GAD-7 total score is the sum of

scores for the 7 items for each participant and ranges from 0 to 21.[27] Among pregnant Peruvian women, the GAD-7 has good reliability, factorial validity, and concurrent validity: the optimal cutoff score obtained by maximizing the Youden Index is 7 with a sensitivity of 73.3% and a specificity of 67.3%.[21] In the present analysis, GAD was defined as the GAD-7 score ≥ 7.

Statistical Analysis

We first examined the frequency distributions of maternal sociodemographics, behavioral characteristics, and reproductive history. We used the Student's *t*-test and the Chi-square test to determine bivariate differences according to sleep quality for continuous and categorical variables, respectively.

We assessed the reliability of the PSQI using several agreement and consistency indices. Specifically, we calculated the Cronbach's α to test the internal consistency for the PSQI. Further, to investigate the factor structure, we completed an exploratory factor analysis (EFA) using the principal component analysis with promax rotation. Before conducting factor analysis, we assessed the suitability for performing the factor analysis. The result of the suitability analysis supported the appropriateness of proceeding with the factor analysis (Bartlett test of sphericity, $p < 0.001$; the Kaiser-Meyer-Olkin measure of sampling adequacy = 0.65). We used the scree plot and eigenvalues associated with each factor to identify the number of meaningful factors. Those factors with eigenvalues > 1 were assumed to be meaningful and retained for rotation.[28] Sleep components with rotated factor loading ≥ 0.4 in absolute value were considered "dominant" and as defining item for each specific factor. We also completed a confirmatory factor analysis (CFA) to complement the EFA. Due to violation of the multivariate normality assumption, we used the weighted least squares (WLS) estimation for the CFA. We calculated the following parameters to evaluate model fit: the comparative fit index (CFI), the standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA). The present study used the following criteria for consideration of a reasonable fit: (1) CFI close to 0.90 or above, (2) SRMR close to 0.08 or below, and (3) RMSEA close to 0.06 or below.[29,30] For the best fit models, we summarized the standardized regression weights for path (factor loadings on each factor) in figures.

As an additional measure of construct validity, we computed the unadjusted and age adjusted Spearman's rank-order correlation coefficients between the PSQI scores with the FIRST, the PHQ-9, and the GAD-7 scales. Given the small percentage of sleep medication use in our study sample, we repeated the analysis excluding "sleep medication use" component. As a post hoc analysis, based on the best fit model of the CFA, we created 3 subscale scores for the PSQI by summing scores of the components that loaded on factors 1, 2, and 3, respectively. We calculated correlation coefficients of the 3 subscale scores with scores derived from the FIRST, PHQ-9, and GAD-7 scales, respectively.

Finally, we fitted multivariate logistic regression models to calculate odds ratios (ORs) and 95% confidence intervals (CIs) of poor sleep quality (yes vs. no) in relation with susceptibility for stress induced sleep disturbance (yes vs. no), depression (yes vs. no), and generalized anxiety disorder (yes vs. no). We included potential confounders of a priori interest (i.e., maternal age, parity, early pregnancy body mass index, difficulty paying for the basic foods, history of childhood physical or sexual abuse, and history of intimate partner violence) in final logistic regression models.

Statistical analyses were performed using SAS 9.4 (SAS Institute, Cary, NC, USA). The level of statistical significance was set at p value < 0.05, and all tests were two-sided.

RESULTS

Table 1 presents sociodemographics and reproductive characteristics of the study population. The mean age of the 642 participants was 28.8 years (standard deviation [SD], 6.5 years). The majority of the participants were married or living with a partner (79.8%), had ≥ 7 years of education (95.8%), and self-identified race/ethnicity as Mestizo (74.3%). The average gestational age of participants at interview was 9.1 weeks (SD 3.6 weeks). On the structured questionnaire, 49.4% of participants reported that they were employed, and 48.9% felt that paying for the very basic food items was "hard." Approximately, 73.7% of the participants have experienced childhood abuse, and 33.2% experienced lifetime intimate partner violence. Based on the PSQI global score, 28.5% of study participants were classified as poor sleepers (PSQI global score > 5) and 71.5% were classified as good sleepers (PSQI global score ≤ 5). Compared with good sleepers, poor sleepers were less likely to be married or living with a partner and report current pregnancy as planned. Poor sleepers were more likely to have difficulty paying for very basic foods and experience childhood abuse and intimate partner violence. Compared with good sleepers, poor sleepers had significantly higher mean total scores on all other measures (i.e., FIRST, PHQ-9, and GAD-7; all p values < 0.0001), reflecting higher degrees of susceptibility for stress induced sleep disturbance and higher depressive and anxiety symptomatology.

Figure 1 shows the distribution of the global PSQI score. Among this population, the global PSQI score ranged from 0 to 15, with a mode of 3. The mean score was 4.5 and the median score was 4. An overall Cronbach's α of 0.57 was observed (**Table 2**) although the assumption for one-factor structure was not met. The correlations between the 7 component scores of the PSQI and the global PSQI score ranged from 0.10 to 0.40 (**Table 2**). In particular, among the 642 participants, only 37 women (5.8% of the cohort) reported that they ever took medicine to help them sleep over the past month, yielding a mean score of 0.08 for "sleep medication use."

The results of the exploratory factor analysis indicated a 3-factor solution with eigenvalues of 1.98, 1.20, and 1.03, corresponding to a sleep quality factor, a sleep efficiency factor, and a sleep medication factor (**Table 3**). These 3 factors together explained 60.10% of the total variance. A series of confirmatory factor analyses was conducted (**Table 4**). Among models including all 7 components (model 1, 2, and 3), model 3, for which 7 components were assigned to 3 factors and allowed correlations between factor 1 and 2, and between factor 1 and 3, indicated an adequate fit: CFI = 0.91, SRMR = 0.03, and RMSEA = 0.04 (**Table 4**). Standardized regression weights for paths associated with model 3 is shown in **Figure 2**. For models

Table 1—Characteristics on the Spanish-language version of the Pittsburgh Sleep Quality Index among pregnant Peruvian women (n = 642).

Selected Variables	All Participants n = 642	Poor Sleep Quality (PSQI > 5) n = 183	Good Sleep Quality (PSQI ≤ 5) n = 459	p value
Maternal age (years), mean ± SD	28.8 ± 6.5	28.6 ± 6.8	28.8 ± 6.4	0.72
Maternal age (years)				
18–20	19 (3.0)	11 (6.0)	8 (1.7)	0.03
20–29	342 (53.3)	93 (50.8)	249 (54.2)	
30–34	145 (22.6)	38 (20.8)	107 (23.3)	
≥ 35	136 (21.2)	41 (22.4)	95 (20.7)	
Education (years)				
≤ 6	26 (4.0)	5 (2.7)	21 (4.6)	0.50
7–12	331 (51.6)	93 (50.8)	238 (51.9)	
> 12	284 (44.2)	85 (46.4)	199 (43.4)	
Mestizo ethnicity	477 (74.3)	129 (70.5)	348 (75.8)	0.16
Married/living with partner	512 (79.8)	137 (74.9)	375 (81.7)	0.05
Employed	317 (49.4)	80 (43.7)	237 (51.6)	0.07
Access to basic foods				
Hard	314 (48.9)	101 (55.2)	213 (46.4)	0.04
Not very hard	328 (51.1)	82 (44.8)	246 (53.6)	
Nulliparous	296 (46.1)	85 (46.4)	211 (46.0)	0.90
Planned pregnancy	263 (41.0)	63 (34.4)	200 (43.6)	0.03
Gestational age (weeks) at interview, mean ± SD	9.1 ± 3.6	9.1 ± 3.7	9.2 ± 3.5	0.81
Early pregnancy body mass index (kg/m^2)				
< 18.5	15 (2.3)	5 (2.7)	10 (2.2)	0.36
18.5–24.9	293 (45.6)	92 (50.3)	201 (43.8)	
25–29.9	237 (36.9)	59 (32.2)	178 (38.8)	
≥ 30	86 (13.4)	22 (12.0)	64 (13.9)	
Childhood physical or sexual abuse	473 (73.7)	150 (82.0)	323 (70.4)	0.0007
Lifetime physical or sexual abuse by intimate partner	213 (33.2)	81 (44.3)	132 (28.8)	< 0.0001
Pittsburgh Sleep Quality Index, mean ± SD	4.5 ± 2.6	7.9 ± 1.9	3.1 ± 1.3	< 0.0001
Ford Insomnia Response to Stress Test, mean ± SD	13.4 ± 4.3	15.9 ± 5.2	12.4 ± 3.4	< 0.0001
Patient Health Questionnaire 9-item, mean ± SD	7.4 ± 5.4	11.1 ± 6.5	5.9 ± 4.0	< 0.0001
Generalized Anxiety Disorder 7-item, mean ± SD	6.0 ± 5.0	9.0 ± 6.1	4.8 ± 4.0	< 0.0001

Values presented as n (%) unless otherwise indicated. Due to missing data, percentages may not add up to 100%. p value was calculated using the Student's *t*-test for continuous variables and the Chi-square test for categorical variables. PSQI, Pittsburgh Sleep Quality Index; SD, standard deviation.

Table 2—Item Characteristics, item-total correlation, alpha if item deleted of the Spanish-language version of the Pittsburgh Sleep Quality Index among pregnant Peruvian women (n = 642).

Components	Mean	SD	Corrected Item-Total Correlation	Alpha if Item Deleted
1. Sleep duration	0.28	0.64	0.26	0.55
2. Sleep disturbance	1.42	0.62	0.29	0.54
3. Sleep latency	0.89	0.93	0.38	0.50
4. Daytime dysfunction due to sleepiness	0.62	0.84	0.40	0.49
5. Sleep efficiency	0.21	0.62	0.22	0.56
6. Overall sleep quality	0.96	0.79	0.38	0.50
7. Sleep medication use	0.08	0.37	0.10	0.58
Global PSQI score	4.46	2.62	N/A	0.57*

*Overall Cronbach's α. PSQI, Pittsburgh Sleep Quality Index; SD, standard deviation.

excluding the component "sleep medication use" (model 4 and 5), model 4, in which "overall sleep quality" only loaded on one factor, demonstrated a better fit: CFI = 0.88, SRMR = 0.03, and RMSEA = 0.05 (**Table 4**).

Table 5 presents correlation coefficients between the global PSQI score and scores derived from the FIRST, the PHQ-9, and the GAD-7 scales. The global PSQI score was significantly positively correlated with the scores of all other measures (all p values < 0.0001). In sensitivity analyses that excluded the "sleep medication use" component from the PSQI global score (excluded because so few women reported using sleep medication), correlation coefficients of similar magnitudes were observed. Further adjustments for maternal age resulted in negligible changes in the magnitude of partial correlation coefficients. Post hoc analyses examining correlation between three data-driven subscale scores of the PSQI and scores derived from the FIRST, PHQ-9, and GAD-7 scales, respectively, were consistent with results obtained using the PSQI global score. The magnitudes of correlation coefficients were stronger for factors 1 and 3 than those estimated for factor 2.

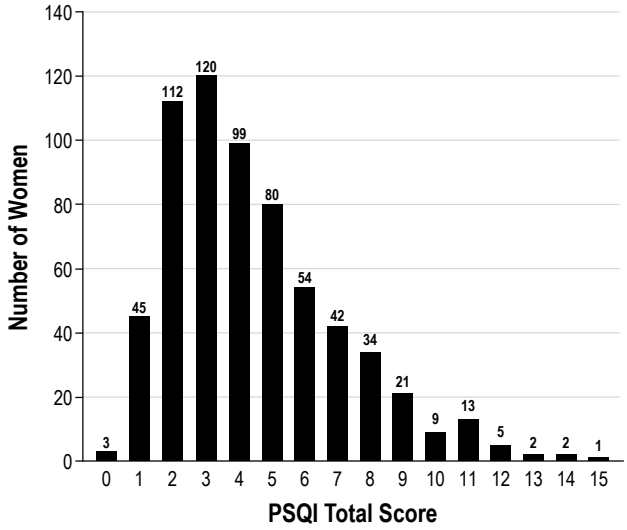
We next completed multivariable logistic regression analyses to assess associations of poor sleep quality (PSQI score > 5) with participants' susceptibility for stress-induced sleep disturbance, depression, and generalized anxiety disorder. After

Table 3—The factor loadings in exploratory factor analysis of the Spanish-language version of the Pittsburgh Sleep Quality Index among pregnant Peruvian women (n = 642).

	Factor Loadings		
Components	**Factor 1**	**Factor 2**	**Factor 3**
1. Sleep duration	0.20	**0.81**	0.00
2. Sleep disturbance	**0.66**	0.02	−0.19
3. Sleep latency	**0.65**	0.15	0.31
4. Daytime dysfunction due to sleepiness	**0.74**	0.16	−0.03
5. Sleep efficiency	0.11	**0.82**	0.07
6. Overall sleep quality	**0.61**	0.22	0.32
7. Sleep medication use	0.06	0.02	**0.92**

Factor loadings ≥ 0.4 are shown in bold.

Figure 1—Distribution of the global score of the Spanish-language version of the Pittsburgh Sleep Quality Index among pregnant Peruvian women (n = 642).



PSQI, Pittsburgh Sleep Quality Index.

Table 4—Models evaluated for the Spanish-language version of the Pittsburgh Sleep Quality Index and corresponding fit indices using confirmatory factor analysis among pregnant Peruvian women (n = 642).

Models	χ^2	**df**	**CFI**	**SRMR**	**RMSEA**
Model 1: 1 factor, 7 components	50.86	14	0.73	0.13	0.06
Model 2: 2 factors (correlated), 7 components (F1: 2, 3, 4 & 6; F2: 1, 5 & 7)	38.35	13	0.81	0.11	0.06
Model 3: 3 factors (correlated*), 7 components (F1: 2, 3, 4 & 6; F2: 1 & 5; F3: 3, 6 & 7)	21.84	10	0.91	0.03	0.04
Model 4: 2 factors (correlated), 6 components (F1: 2, 3, 4 & 6; F2: 1 & 5)	23.03	8	0.88	0.03	0.05
Model 5: 2 factors (correlated), 6 components (F1: 2, 3, 4 & 6; F2: 1, 5 & 6)	21.19	7	0.89	0.03	0.06

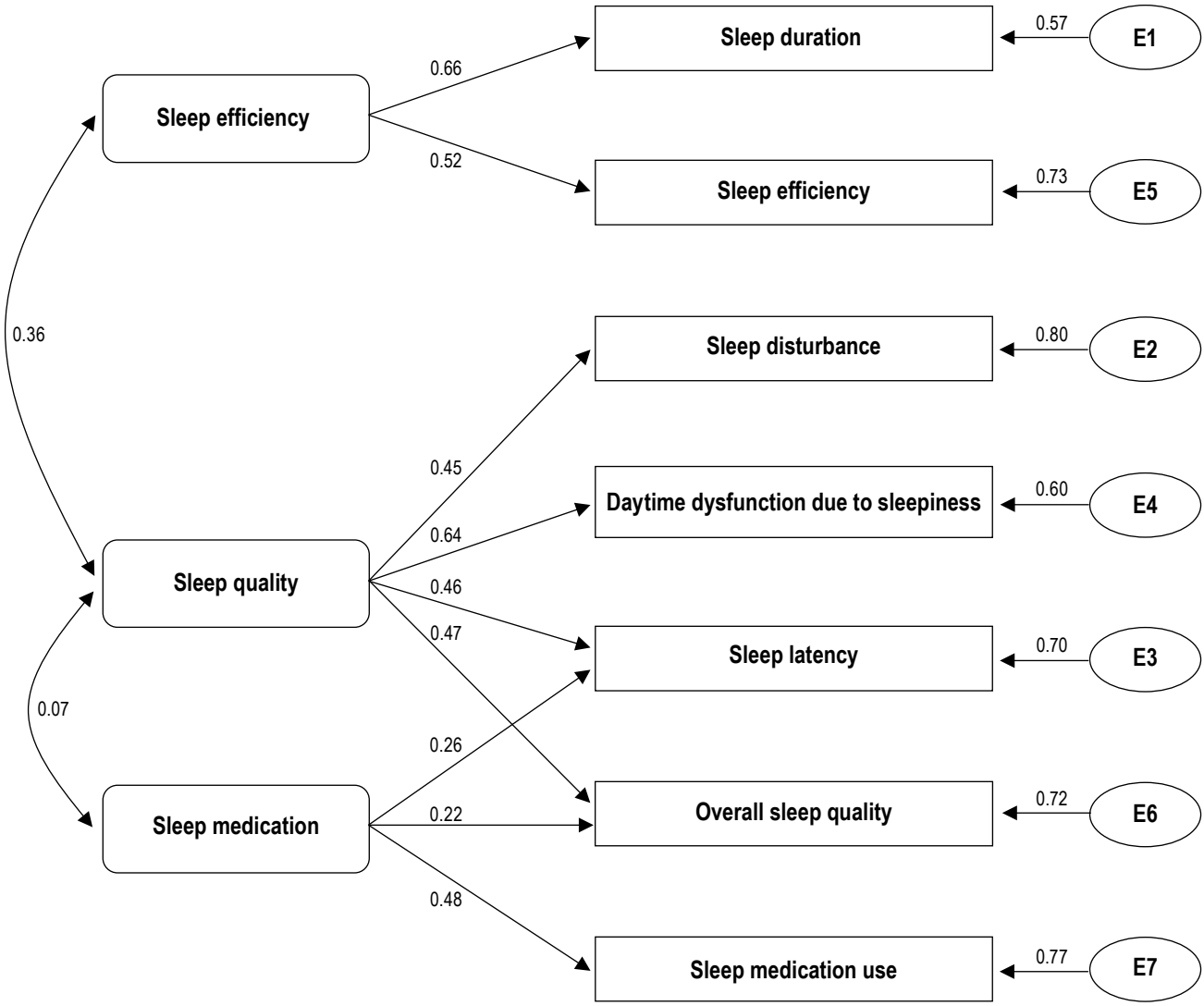
*Factor 1 and factor 2 are correlated; factor 1 and factor 3 are correlated. df, degree of freedom; CFI, comparative fit index; SRMR, standardized root mean square residual; RMSEA, root mean square error of approximation.

Table 5—Correlations between scores of the Spanish-language version of the Pittsburgh Sleep Quality Index and other measures (n = 642).

	FIRST		PHQ-9		GAD-7	
PSQI	**Unadjusted**	**Adjusted***	**Unadjusted**	**Adjusted***	**Unadjusted**	**Adjusted***
Global PSQI score	0.42†	0.42†	0.49†	0.49†	0.46†	0.46†
Global PSQI score excluding component 7	0.42†	0.42†	0.49†	0.49†	0.47†	0.46†
Factor 1 (Component 2, 3, 4 & 6)	0.46†	0.47†	0.53†	0.52†	0.49†	0.49†
Factor 2 (Component 1 & 5)	0.04	0.04	0.11§	0.11§	0.11§	0.11§
Factor 3 (Component 3, 6 & 7)	0.35†	0.35†	0.40†	0.40†	0.31†	0.30†

*Adjusted for maternal age. †p value < 0.0001. §p value < 0.05. PSQI, Pittsburgh Sleep Quality Index; FIRST, the Ford Insomnia Response to Stress Test; PHQ-9, the Patient Health Questionnaire 9-item; GAD-7, Generalized Anxiety Disorder 7-item.

Figure 2—Standardized regression weights for paths associated with the best fit model for the Pittsburgh Sleep Quality Index among pregnant Peruvian women (n = 642).



adjusting for possible confounding by maternal age, parity, early pregnancy body mass index, difficulty paying for the basic foods, history of childhood physical or sexual abuse, and history of intimate partner violence, we found that poor sleep quality was associated with a 3.57-fold increased odds (95% CI: 2.40, 5.31) of susceptibility for stress-induced sleep disturbance (**Table 6**). Furthermore, as compared with good sleepers, we noted that poor sleepers had a 5.48-fold increased odds (95% CI: 3.58, 8.37) of depression (PHQ-9 ≥ 10), and a 4.57-fold increased odds (95% CI: 3.08, 6.76) of generalized anxiety disorder (GAD-7 ≥ 7) (**Table 6**).

DISCUSSION

The Spanish-language version of the PSQI demonstrated good construct validity when used among a cohort of low-income pregnant Peruvian women. Both exploratory and confirmatory factor analyses indicated a three-factor solution: sleep quality, sleep efficiency, and sleep medication. Although the assumption for one-factor structure was not met, an overall Cronbach's α of 0.57 was reported. Women classified as having poor sleep quality in early pregnancy (i.e., poor sleepers; PSQI global score > 5) had significantly increased odds of being susceptible to stress induced sleep disturbance (OR = 3.57; 95% CI: 2.40, 5.31), depression (OR = 5.48; 95% CI: 3.58, 8.37), and generalized anxiety disorder (OR = 4.57; 95% CI: 3.08, 6.76). Removal of the component "sleep medication use" (a component that was endorsed by 5.8% of the participants) neither improved the fit of the CFA models nor had a noticeable influence on the construct validity of the PSQI.

Exploratory factor analysis yielded a three-factor structure, including a sleep quality factor, a sleep efficiency factor, and a sleep medication factor. Based on the results of confirmatory factor analysis, the one-factor structure of Buysse[17] did not fully capture the multidimensional nature of sleep disturbance with a poor fit. A three-factor model demonstrated a better fit than the one-factor model, which was consistent with reports from several previous studies.[12,14,18,31] Of note, the three factors

Table 6—Associations between the Spanish-language version of the Pittsburgh Sleep Quality Index and other measures (n = 642).

	Poor Sleep Quality (PSQI > 5) n = 183 n (%)	Good Sleep Quality (PSQI ≤ 5) n = 459 n (%)	Unadjusted OR (95% CI)	Adjusted* OR (95% CI)	Adjusted† OR (95% CI)
FIRST					
High FIRST scores (FIRST > 12)	128 (69.9)	185 (40.3)	3.54 (2.44, 5.13)	3.64 (2.48, 5.35)	3.57 (2.40, 5.31)
Low FIRST scores (FIRST ≤ 12)	53 (29.0)	271 (59.0)			
PHQ-9					
MDD (PHQ-9 ≥ 10)	89 (48.6)	67 (14.6)	5.57 (3.77, 8.22)	5.72 (3.79, 8.65)	5.48 (3.58, 8.37)
No depression (PHQ-9 < 10)	93 (50.8)	390 (85.0)			
GAD-7					
GAD (GAD-7 ≥ 7)	107 (58.5)	111 (24.2)	4.42 (3.06, 6.37)	4.51 (3.09, 6.60)	4.57 (3.08, 6.76)
No GAD (GAD-7 < 7)	74 (40.4)	339 (73.9)			

Due to missing data, percentages may not add up to 100%. *Adjusted for maternal age (years), parity (multiparous vs. nulliparous), early pregnancy body mass index (kg/m^2) (< 18.5; 18.5–24.9; 25–29.9; ≥ 30), and difficulty paying for the basic foods (hard vs. not very hard). †Further adjusted for history of childhood physical or sexual abuse (yes vs. no) and history of intimate partner violence (yes vs. no). PSQI, Pittsburgh Sleep Quality Index; OR, odds ratio; CI, confidence interval; FIRST, the Ford Insomnia Response to Stress Test; PHQ-9, the Patient Health Questionnaire 9-item; MDD, major depressive disorder; GAD-7, Generalized Anxiety Disorder 7-item; GAD, generalized anxiety disorder.

derived from previous studies have not been consistent. For example, using the principal component analysis, in a sample of 600 Nigerian university students, Aloba et al.[12] reported that the best fit model yielded the following three factors: sleep quality, sleep duration, and sleep efficiency. In another U.S. study of 187 community-dwelling adults, Buysse and colleagues reported that three factors (i.e., sleep quality, sleep duration, and sleep medication) provided the best fit with their data.[32] Recently, in our study of male and female Peruvian college students, we found that three factors (i.e., sleep quality, sleep efficiency, and sleep latency) resulted from our best fitting model.[18] Lastly, in studies of community-dwelling older adults in the U.S.[31] and renal transplant recipients in Switzerland,[14] investigators completed confirmatory factor analyses and observed three-factor models as follows: sleep efficiency, sleep quality, and daytime dysfunction. Although several three-factor models have been reported, the specific contents of the three factors varied across previous studies. Differences in culture, demographics, and linguistics may contribute to observed variations.[18] Future studies are warranted to further explore underlying explanations of these observed differences.

Investigators have argued that the three-factor structure of the PSQI has the clinical advantage of obtaining multiple dimensions of sleep problems from a single questionnaire. Cole and colleagues have argued that relying solely on the PSQI global score may not identify disturbances that only reside on one of the three PSQI factors.[31] However, despite accumulating evidence in favor of a three-factor structure of the PSQI across medically and ethnically diverse research populations, studies designed to further validate the three-factor structure of the PSQI across populations and to assess the comparative validity and clinical utility of the three, factor-specific scoring versus the single global score of the PSQI are warranted.

The PSQI demonstrated good construct validity in our study population. We found that that the PSQI global score and two of the subscale scores were moderately correlated with stress-induced sleep disturbance (assessed using the FIRST), depressive symptoms (assessed using the PHQ-9), and symptoms of generalized anxiety disorder (assessed using the GAD-7). Neither maternal age nor "sleep medication use" had a noticeable influence on these correlations. Our findings are similar to reports from other investigators. For example, among a sample of 161 Japanese men and non-pregnant women, Nakajima and colleagues reported statistically significant correlations of scores from the PSQI and the FIRST.[23] These results and those of ours suggest that the PSQI and the FIRST were measuring similar constructs. Likewise, reports of correlations of the PSQI score with scores from scales designed to measure symptoms of mood and anxiety disorders support the similarity in constructs between scales and reinforce evidence from clinical epidemiological studies documenting high degrees of comorbidity between sleep and psychiatric disorders.[1,16,33] An important note of threat to inferences from studies relying on self-report of sleep and mood disorders merits consideration. Namely, it is important to note here that Beck cautioned investigators to the likelihood that altered mood states (e.g., depression and anxiety) may influence perceptions of physiological state including somatic symptoms[16,34,35]; hence, observed associations (based on participants' self-report) may be subject to bias.

In our study, given that three factors have been derived from factor analysis, an overall Cronbach's α cannot simply be interpreted as an index for the internal consistency of the PSQI because calculation for the Cronbach's α requires that all items measure the same construct.[36,37] Our review of the published literature revealed a wide range of reported Cronbach α for the PSQI, with a low of 0.43 (among Japanese healthy participants) to a high of 0.85 (among German patients with insomnia).[8–11,13,15–17,38] Although the statistic is not interpretable in our study (given the observed three-factor structure), we reported an overall Cronbach's α (0.57) so as to be consistent with the other studies.

Several previous studies conducted among pregnant Australian and British women,[1,7] Norwegian postpartum women,[39] Australian adults,[40] and cancer patients in Greece[8] found that the removal of "sleep medication use" component improved the Cronbach's α for the PSQI. Jomeen et al. reported that removal of this component (which was endorsed by < 3% of participants) contributed to the excellent general fit of a CFA model and recommended to remove this component from the global PSQI score calculation within the context of early pregnancy.[1] However, among Australian adults, Magee et al.[40] observed that removal of "sleep medication use" (endorsed by 3.9% of participants) did not have a major impact on the model fit of the CFA models. Similarly, in our population, excluding "sleep medication use" did not improve the fit of CFA models. In addition, the removal resulted in negligible changes in the magnitude of partial correlation coefficients between the PSQI with the FIRST, PHQ-9, and GAD-7 scales. Of note, removing "sleep medication use" will change the original cutoff scores (PSQI global score > 5) in defining poor sleepers. More research is warranted to determine whether the component "sleep medication use" should be included for calculating the PSQI global score among pregnant women.

The present study has several limitations. First, objective measurements of sleep were not available (e.g., actigraphy or polysomnography), precluding evaluation of associations between the questionnaire-based measures and objective measurements of sleep. Further, this study was a cross-sectional study. It did not provide information regarding the persistence of poor sleep quality over time and the extent to which poor sleep quality was associated with adverse perinatal outcomes. In addition, we cannot establish the temporal relation between sleep quality, other measures of sleep disturbance and mood or anxiety disorders. Longitudinal studies are warranted to follow up women during pregnancy and postpartum and to estimate the bi-directional associations of sleep and psychiatric disorders in this population. Despite these limitations, this is the first study to evaluate the psychometric properties of the Spanish-language version of the PSQI among pregnant women. Another strength of this study was the relatively larger sample of pregnant women in early pregnancy, which allowed us to examine factor structures and to ensure the stability of the factor solution. Moreover, our study made allowances for assessing relations of PSQI assessed sleep quality with multiple other measures of sleep disturbances, and mood and anxiety disorders.

CONCLUSION

The Spanish-language version of the PSQI was appropriate for use with good construct validity among pregnant Peruvian women. The reported overall Cronbach's α cannot simply be interpreted as an index for the internal consistency of the PSQI. Poor sleepers had statistically significantly increased odds of being susceptibility for stress induced sleep disturbance, depression, and generalized anxiety disorder. Removal of the component "sleep medication use" neither improved the fit of the CFA models nor had a noticeable influence on the construct validity of the PSQI. Future studies are needed to further validate the three-factor structure among diverse populations, address whether the three, factor-specific scoring of the PSQI is favored over the PSQI global score, and determine whether the component "sleep medication use" should be included for calculating the PSQI global score among pregnant women. Future development of screening and treatment programs targeting sleep disturbance during the first trimester are warranted to mitigate the risk of mood disorders during late pregnancy and postpartum.

ABBREVIATIONS

CFA, confirmatory factor analysis
CFI, comparative fit index
CI, confidence interval
df, degree of freedom
DSM, Diagnostic and Statistical Manual of Mental Disorders
EFA, exploratory factor analysis
FIRST, Ford Insomnia Response to Stress Test
GAD, generalized anxiety disorder
GAD-7, Generalized Anxiety Disorder 7-item
INMP, Instituto Nacional Materno Perinatal
MDD, major depressive disorder
OR, odds ratio
PHQ-9, Patient Health Questionnaire 9-item
PSQI, Pittsburgh Sleep Quality Index
RMSEA, root mean square error of approximation
SD, standard deviation
SRMR, standardized root mean square residual
WLS, weighted least squares

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