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Psychometric properties of the Mongolian version of the Pittsburgh Sleep Quality Index

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Abstract: Poor sleep quality is associated with decreased brain health, such as fatigue, low quality of life, and risk of neurological and psychiatric comorbidities. Until now, no testing instruments for an accurate assessment of sleep quality for use in the general population have been rigorously translated and validated in Mongolia. We aimed to determine the psychometric properties of the globally recognized screening tool and sleep quality in the general population of Mongolia. In this cross-sectional study, participants were randomly selected between August and October 2020, from 64 sites in 8 urban, and 9 rural areas in Mongolia. Of the total 1152 participants (mean age, SD=42.66±12.6, range: 18 and 65) 76% were women. An overall Cronbach's α was 0.69. Both EFA and CFA indicated a two-factor solution. The PSQI total score was positively correlated with anxiety and depression. The PSQI total score (p values < 0.01) was negatively correlated with the mean scores of all domains of WHOQOL-BREF. The mean PSQI total score was 5.67±3.4 and 43% of the participants were classified as poor sleepers by a global cut-off point of 5. The Mongolian version of the PSQI demonstrated a reliable and valid tool for screening sleep quality among the Mongolian general population. The results suggest that the prevalence rate of poor sleep quality was 43% using PSQI global cut-off point.

Keywords: Sleep quality; PSQI; Mongolia; Normative data

1.0 INTRODUCTION

People who get enough quality sleep have more energy, better cognitive function, healthier immune systems, and improved memory, alertness, attentiveness, and performance throughout the day (Banks & Dinges, 2007). Poor sleep quality is associated with decreased brain health, such as fatigue, low quality of life, and risk of neurological and psychiatric comorbidities (Cable et al., 2017; Ford & Kamerow, 1989; Li et al., 2016). Sleep restriction impairs neurocognitive functioning that negatively impacts health and well-being (Lowe et al., 2017; Stranges et al., 2012). Therefore, it is essential to examine sleep quality in the general population of Mongolia.

Sleep quality can be measured with both objective, and subjective instruments. Therefore, an accurate assessment of sleep quality within a population requires rigorous validation of testing instruments and protocols (Mollayeva et al., 2016). Until now, no testing instruments for an accurate assessment of sleep quality for use in the general population have been rigorously translated and validated in Mongolia. 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 the clinical and non-clinical populations in diverse global settings. We conducted a nationwide population-based, cross-sectional study to validate the PSQI, a globally recognized psychometric measure of sleep quality (Buysse et al., 1989). In addition to the PSQI, we used the World Health Organization Quality of Life Assessment (WHOQOL-BREF), a QoL assessment developed by the World Health Organization (WHO) (Skevington & Epton, 2018).

In the past two decades, epidemiological studies have examined the prevalence of poor sleep quality among the population in various countries. Several studies explored sleep quality among the population in low- and middle-income countries in Africa, Asia and North America, with the prevalence ranging from 8.3% to 17% (Stranges et al., 2012).

This study aims to determine the psychometric properties of the Mongolian version of PSQI, a globally recognized screening tool for sleep quality, in the general population of Mongolia.

2.0 MATERIALS AND METHODS

In this cross-sectional study, we randomly selected 40 individuals aged 18 or older from each center. This is the nested validation study from the Mon-TimeLine interdisciplinary clinical cohort study to investigate brain-related disorders in Mongolia (Tumurbaatar et al., 2021a). Participants who lived in the administrative units for at least 6 months, were literate in the Cyrillic Mongolian language, and were not admitted to any clinical setting were considered to meet inclusion criteria. Participants who were not able to read, and understand scale items, and generally not able to answer the scale independently were excluded. If selected participants were not available at the center for the paper-based questionnaire assessment, they were replaced by the next available participants regardless of age and sex category. The flowchart of the study participants is shown in **Figure 1**.

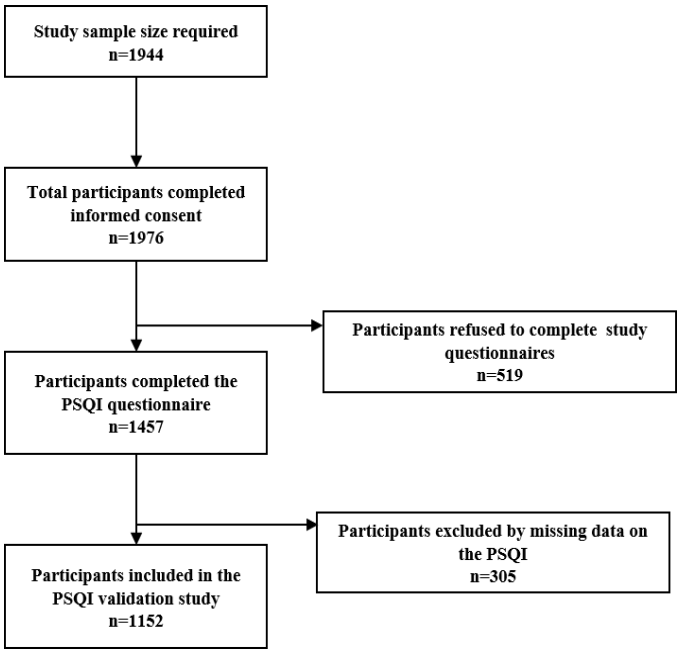

Figure 1. Flowchart of the study participants. A total of 1944 participants were included in analysis from the cohort with completed informed consent. From this cohort, 519 participants refused to complete the study questionnaire, and 305 participants excluded by missing data. The final sample in the present analysis included 1152 patients.

Written informed consent was obtained from all participants. The institutional review board and Ethics committee of the MNUMS approved the study protocol and procedures for informed consent on 2020/03-05.

Pittsburgh Sleep Quality Index (PSQI)

The PSQI is a self-report questionnaire containing 19 response items, which are further divided into 7 categories: sleep duration (C1), sleep disturbance (C2),

sleep latency (C3), daytime dysfunction due to sleepiness (C4), sleep efficiency (C5), overall sleep quality (C6), and sleep medication use (C7). Each category is given a score from 0 to 3, where a higher value indicates dysfunction. The total score ranges from 0 to 21, with a score above 5 indicating poor sleep quality. The cut-off value of 5 was chosen by Buysse et al. as the optimal cut-off score based on a receiver operating curve (ROC) comparison to polysomnographic tests with a sensitivity of 89.6%, and a specificity of 86.5%.

We translated the PSQI into Mongolian based on the guidelines for the cross-cultural adaptation of such instruments (Beaton et al., 2000). Then we conducted a pilot test to examine the understanding of items and the ability to answer, as well as the meaningfulness of the scale as a whole. Back-translation was then performed independently by two translators unfamiliar with the original PSQI and revealed no meaningful disagreement with the original version. In the next step, the expert committee re-evaluated item translation based on the pilot test and reviewed the back-translation process. Finally, we administered the Mongolian version of PSQI to study participants. The lead authors of the PSQI, which owns the copyright, have permitted to use and granted the license for the use of the questionnaire.

World Health Organization Quality of Life Assessment (WHOQOL-BREF)

The WHOQOL Group defines the quality of life (QoL) as "an individual's perception of their position in life, in the context of the culture and value systems in which they live, and in relation to their goals, expectations, standards, and concerns." It is a broad-ranging concept affected in a complex way by the person's physical health (Domain 1), psychological state (Domain 2), social relationships (Domain 3), and their relationship to salient features of their environment (Domain 4). We used to develop short-form WHOQOL-BREF to assess the QoL associated with sleep problems among the Mongolian population. It has a number of advantages, as it is one of the most commonly used generic QoL questionnaires developed by the WHOQOL group in 1996. The questionnaire has a short completion time and is suitable for large-sample surveys or clinical trials in clinical and non-clinical populations. It is open source and free to use for non-commercial purposes, and has been translated into about 40 different languages. The Mongolian version of the structured WHOQOL-BREF includes 26 standard items from the original WHOQOL-BREF including two items on the General QoL and General Health questionnaires. The remaining 24 items, on a five-point scale, are classified into four domains. The total score for each domain is converted to a score that ranges either from 4 to 20 or from 0 to 100, with low scores indicating poor QoL (Skevington & Epton, 2018). The Mongolian version of the WHOQOL-BREF was used in our study, which was developed by Bat-Erdene et al. and showed good test-retest reliability, internal consistency, and validity (Bat-Erdene E., 2023).

Hospital Anxiety Depression Scale (HADS)

The psychological symptoms were assessed using the HADS. The questionnaire consists of 14 items, seven of them are for anxiety and the remaining seven are for depression. Individuals might feel tested for certain mental disorders; thus, any symptoms of severe psychopathology are not included intending to increase acceptability and preclude. This makes HADS more sensitive to milder psychopathology. The ranges of scores for cases on each subscale are 0–7 or normal, 8–10 or mild disorder, 11–14 or moderate disorder, and 15–21 or severe disorder (Zigmond & Snaith, 1983). The two-factor Mongolian version of the HADS had been validated in the general population (Tumurbaatar et al., 2021b).

Statistical Analysis

Data were presented as a mean, standard deviation. Distributions of continuous variables were tested by the Kolmogorov Smirnov test. The internal consistency of the PSQI was estimated using Cronbach's α test. Further, to investigate the factor structure, we completed an exploratory factor analysis (EFA) using the principal component analysis (PCA) with varimax rotation, as well as confirmatory factor analysis (CFA) to supplement EFA. The CFA of the Mongolian version of the PSQI was carried out using AMOS 26.0 statistical software. The present study used the following criteria for the structural equation modelling: (1) goodness-of-fit index (CFI) close to 0.90 or above, (2) standardized Root Mean Square Residual (SRMR) close to 0.08 or below, and (3) root mean square error of approximation (RMSEA) close to 0.06 or below. As an additional measure convergent and discriminant validity using the correlation analyses were performed using Spearman's rank-order correlation coefficients. The statistical significance level was set at $p < 0.05$ (two-sided).

3.0 RESULTS

A total of 1152 participants completed the survey questionnaire. The average age was 42.66 years (standard deviation (SD): 12.6, range: 18-65), 876 (76%) were women, 354 (30.7%) held a bachelor's degree or above, 852 (74.2%) were married, and 567 (49.2%) were

Table 1. Demographic characteristics of participants

Selected Variables		Total, n (%) 1152 (100)	
Gender	Male	276	(24)
	Female	876	(76)
Participants' age (years), mean ± SD		42.55	±12.6
Age by groups (years)	18–29	212	(18.4)
	30–39	263	(22.6)
	40-49	292	(25.3)
	50-59	263	(22.8)
	>60	122	(10.6)
Marital status	Married	852	(74)
	Never married	154	(13.4)
	Others#	146	(12.7)
Education	Middle school and below	481	(41.8)
	Associate's degree	317	(27.5)
	Bachelor's degree	311	(27)
	Master's degree and above	43	(3.7)
Income	<175$	692	(60.1)
	175-525	441	(38.3)
	>525$	19	(1.6)
Living condition	Apartment	373	(32.4)
	Ger	372	(32.4)
	House	379	(32.9)
	Others	28	(2.4)
Place of residency	Ulaanbaatar	567	(49.2)
	Rural areas	585	(50.8)

#Others included re-married, co-habiting, separated, divorced, and widowed, SD (standard deviation).

residents of Ulaanbaatar city. Other demographic characteristics are shown in **Table 1**. The homogeneity of items was tested by calculating Cronbach's α and the overall reliability coefficient for total PSQI was 0.69. Subscale scores were significantly correlated to the PSQI total score and the corrected item-total correlation ranged from 0.270 to 0.498 **(Table 2)**.

The results of the EFA indicated a 2-factor solution with eigenvalues of 2.56, and 1.44. The first 'sleep quality' and the second 'sleep efficiency' factors were extracted using varimax rotation. C2, C3, C4, C6, and C7 were loaded on the first factor, while the rest of the components had good loadings on the second factor **(Table 3)**. These two factors together explained 57.1 % of the total variance.

Table 2. Internal consistency of the Mongolian version of the PSQI

Components	Mean	SD	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
C1: Duration	0.85	1.015	0.496	0.628
C2: Disturbance	0.88	0.624	0.398	0.661
C3: Latency	1.05	0.921	0.498	0.627
C4: Sleepiness	1.13	0.623	0.498	0.640
C5: Efficiency	1.23	1.133	0.431	0.657
C6: Overall quality	0.16	0.542	0.280	0.684
C7: Medication	0.37	0.696	0.270	0.687
The PSQI total score	**5.67**	**3.4**	**N/A**	**0.69***

*Overall Cronbach's alpha PSQI

Table 3. The factor loadings of the Mongolian version of the PSQI

Components	Two-factor	
	Factor 1	Factor 2
C1: Duration	0.11	**0.88**
C2: Disturbance	**0.75**	0.05
C3: Latency	**0.57**	0.42
C4: Sleepiness	**0.74**	0.20
C5: Efficiency	0.05	**0.89**
C6: Overall quality	**0.48**	0.13
C7: Medication	**0.72**	-0.13

The aim of CFA in this investigation was to determine whether or not the components previously identified were valid. In the CFA, the 2 factors and 7 components extracted from the PCA were allowed correlations between factors 1 and 2, and provided a similar but marginally better fit to the data than the single-factor and three-factor models. The model had relatively low fit indices (RMSEA = 0.088; CFI = 0.931; TLI = 0.888) and a test for exact fit showed a significant difference ($\chi 2()=129$; $p=0.001$). The arrows in **Figure 2** are the factor loadings, representing the direct effects of the indicators on the PSQI. Standardized regression weights for paths associated with the 2-factor model are shown in **Figure 2**.

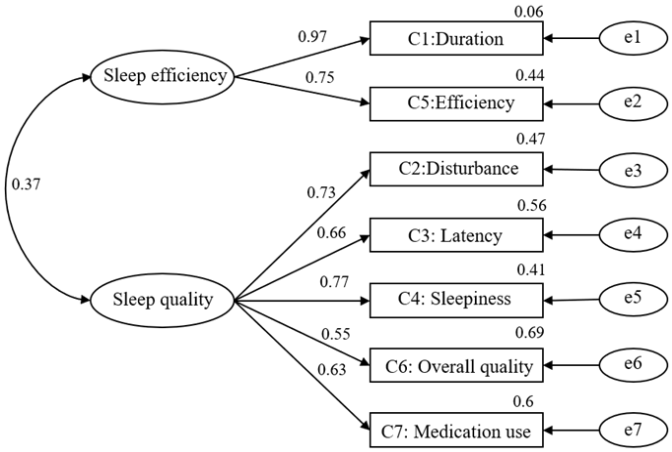

Figure 2. Standardized regression weights for paths associated with the best fit model for the Mongolian version of PSQI. The value 0.37 is the correlation between Efficiency and Quality of sleep. The values 0.97, 0.75, 0.73, 0.66, 0.77, 0.55, and 0.63are standardized regression weights. The measurement error represented as e1-e9. The value 0.06, 0.44, 0.47, 0.56, 0.41, 0.69, and 0.60 are the squared multiple correlations of Sleep quality with Efficiency and Quality of sleep. The factor analysis model employed here is adapted from Jöreskog and Sörbom (1984).

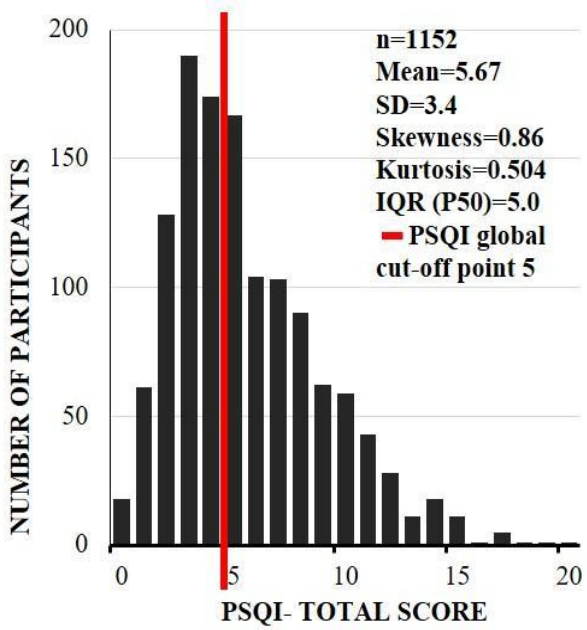

Figure 3. Distribution of the Mongolian version of PSQI total score. Among the general population, the PSQI total score ranged from 0 to 20, with a mode of 3. The mean score was 5.67. The red vertical line indicates the PSQI global cut-off score of 5.

As shown in **Table 4**, the PSQI scores were significantly correlated with the WHOQOL-BREF Domain 1, Domain 2, Domain 3, Domain 4 and HADS anxiety and depression scores $p < 0.01$, were -0.375; -0.312; -0.213; -0.297; 0.261; 0.145, respectively. The PSQI score showed inverse relationships with the WHOQOL-BREF scores, whereas direct relationships with the HADS scores.

Normative scores of the PSQI were obtained separately for each gender and age groups **(Table 5)**. Percentile/ quartile values would be as follows: PSQI total score < P25: good/very good; Percentile 25 to Percentile 50: good to average; from Percentile 50 to Percentile75: average to poor; and equal or greater than Percentile 75: poor/very poor sleep quality.

Figure 3 shows the distribution of the PSQI total score. Among the general population, the PSQI total score ranged from 0 to 20, and the mean score was 5.67±3.4. Based on the PSQI global score with a cut-off point of 5, 43% of study participants were classified as poor sleepers (PSQI global score > 5) and 57% were classified as good sleepers (PSQI global score ≤ 5).

4.0 DISCUSSION

Considering the negative impact of poor sleep quality on health, and mental status it is essential to determine poor sleep quality and validate an instrument that measures sleep quality in the Mongolian general population. This is the first study to examine the psychometric properties of the Mongolian version of the PSQI. An overall Cronbach's α cannot simply be interpreted as an index for the internal consistency of the PSQI because the calculation for Cronbach's α requires that all items measure the same construct (Bland & Altman, 1997; Tavakol & Dennick, 2011). Our review of the published literature revealed a wide range of reported Cronbach α for the PSQI, with a low of 0.43 to a high of 0.8 (Beck et al., 2004; Buysse et al., 1989; Doi et al., 2000). Given the single-factor structure, we reported an overall Cronbach's α 0.69, consistent with the other studies.

Based on the results of both EFA and CFA, a two-factor model demonstrated a better fit than the one-factor model proposed by Buysse (Buysse et al., 1989), which was consistent with reports from several previous studies (Dunleavy et al., 2019; Raniti et al., 2018).

Table 4. Correlation analyses

	Domain 1	Domain 2	Domain 3	Domain 4	Anxiety score	Depression score
C1: Duration	-0.158*	-0.112*	-0.075*	-0.088*	0.082*	0.056*
C2: Disturbance	-0.358*	-0.271*	-0.191*	-0.302*	0.205*	0.16*
C3: Latency	-0.345*	-0.246*	-0.159*	-0.248*	0.239*	0.153*
C4: Sleepiness	-0.358*	-0.297*	-0.19*	-0.28*	0.299*	0.154*
C5: Efficiency	-0.067*	-0.118*	-0.106*	-0.099*	0.094*	0.045*
C6: Overall quality	-0.197*	-0.191*	-0.088*	-0.145*	0.145*	0.077*
C7: Medication	-0.241*	-0.202*	-0.142*	-0.22*	0.183*	0.087*
PSQI total score	-0.375*	-0.312*	-0.213*	-0.297*	0.261*	0.145*

*Significance p< 0.01, and tested using Spearman's rank-order correlation.

Table 5. Normative data of the PSQI

Characteristics		Mean±SD	Skewness± SE	Kurtosis±SE	IQR
Total participant		5.67±3.40	0.860±0.072	0.504±0.144	5.00(3.00~8.00)
Gender	**Male**	5.64±3.46	0.831±0.147	0.286±0.292	5.00(3.00~8.00)
	Female	5.68±3.38	0.871±0.083	0.587±0.165	5.00(3.00~8.00)
Age group	**<19**	5.97±3.22	0.409±0.421	-0.620±0.821	5.00(3.00~9.00)
	20-29	5.61±3.25	0.658±0.181	-0.123±0.359	5.00(3.00~8.00)
	30-39	5.64±3.19	0.696±0.150	-0.010±0.299	5.00(3.00~8.00)
	40-49	5.61±3.32	1.023±0.143	1.123±0.284	5.00(3.00~7.00)
	50-59	5.67±3.59	0.919±0.150	0.605±0.299	5.00(3.00~8.00)
	>60	5.93±3.91	0.895±0.219	0.388±0.435	5.00(3.00~9.00)

Studies designed to further validate the three-factor structure of the PSQI across clinical, and ethnically diverse research populations are warranted in order to assess the comparative validity and clinical utility of the three-factor specific scoring (Cole et al., 2006; Gelaye et al., 2014), and the single global score of the PSQI. In view of the factor analysis literature, it is no accident that the present model fits very well. Future studies are warranted to further explore variation between populations due to differences in culture, demographics, and linguistics.

The Mongolian version of the PSQI demonstrated a reliable and valid tool for screening sleep quality among the Mongolian general population. The PSQI scores showed direct relationships with anxiety and depression, consistent with the reports from other studies (Qiu et al., 2016; Zhong et al., 2015). Furthermore, the PSQI scores had inverse relationships with quality of life, in agreement with previous studies (Nunes et al., 2009; Ichikawa et al., 2022).

In this population-based study, we showed that poor sleep quality in 43% of the population in Mongolia. This is consistent with findings of other studies done around the globe, which showed a higher prevalence of poor quality of sleep ranging from 36.4% to 48.1% (Dağ & Kutlu, 2017; Ju et al., 2021). In comparison, a multinational, large-scale study of sleep disturbances among populations of eight developing countries showed a 17% rate of sleep problems (Stranges et al., 2012), suggesting sleep quality is a serious mental health issue in Mongolia compared to other countries. However, previous studies in China and Russia showed similar levels of poor sleep quality to our result. In the Chinese population, the prevalence of poor sleep quality was reported to be 33.8%-41.5% (Luo et al., 2013). In Russia, the prevalence of poor sleep quality was reported at 56% among students (Kolomeychuk et al., 2016).

First, most sleep studies were performed in Western countries, and few have been conducted in developing

countries. So, due to differences in lifestyle and culture, findings from previous studies might not be applicable to the general population of Mongolia in particular. The present study was limited to a cross-sectional study, meaning it did not provide information regarding the persistence of poor sleep quality over time. Longitudinal studies are warranted to estimate the bi-directional associations of sleep quality in this population. Finally, this study did not include varied diagnostic samples and did not use diagnostic standard technologies such as sleep monitors, polysomnography. Thus, sensitivity, specificity, known-group validity (discriminant), and criterion validity could not be evaluated. Despite these limitations, this is the first study to evaluate the psychometric properties of the Mongolian version of the PSQI among the general population of Mongolia. Given the relatively large sample size, we were able to examine factor structures and ensure the stability of the factor solution. Hence, this study is an important validation of the PSQI in Mongolia, and provides an assessment of the tool's advantages and disadvantages for future work on sleep quality.

5.0 CONCLUSIONS

The Mongolian version of the PSQI demonstrated a reliable and valid tool for screening sleep quality among the Mongolian general population. The results suggest that the prevalence rate of poor sleep quality was 43% using PSQI global cut-off point for the nonclinical general population.

Author Contributions: B.L., C.E., and T.J. conceived and designed the study; B.L., E.T., T.A., M.D., and G.T. performed and collected data; B.L., E.T., E.B., and G.T. analyzed the data; T.J and D.B. contributed reagents and materials; B.L., D.B., T.J., and T.H. reviewed and edited the paper; B.L. and E.T. wrote the paper.

Conflicts of Interest: The authors declare no conflict of interest.

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