Published in final edited form as:

J Chin Med Assoc. 2018 March ; 81(3): 242–247. doi:10.1016/j.jcma.2017.06.021.

Adaptation of the Pittsburgh Sleep Quality Index in Chinese adults with type 2 diabetes

Bingqian Zhu[a,*], **Meng Xie**[b], **Chang G. Park**[a], **Mary C. Kapella**[a]

[a]College of Nursing, The University of Illinois at Chicago, Chicago, IL, USA

[b]Department of Spinal Surgery, Changzheng Hospital, Second Military Medical University of China, Shanghai, China

Abstract

Background: Sleep disturbance is a major health issue in people with type 2 diabetes (T2DM). The Pittsburgh Sleep Quality Index (PSQI) has been the most widely used instrument to measure subjective sleep disturbance. Nevertheless, its factor structure in the context of T2DM has not been examined. The purpose of the study is to evaluate the factor structure of the PSQI in Chinese adults with T2DM and thereby to facilitate its use in clinical practice and research.

Methods: The PSQI (Chinese version) was administered to 240 patients with T2DM. Confirmatory factor analysis was conducted to examine the one-factor, adapted one-factor by removing the component "use of sleep medication", and the three-factor structure of the PSQI. Goodness-of-fit indices were used to evaluate the fit of the model. Construct validity of the resultant model was further examined using contrasted groups. Cronbach's α of the resultant model was obtained to evaluate its internal consistency.

Results: The three-factor model proposed by Cole et al. did not fit the sleep data. Confirmatory factor analysis supported the adapted one-factor model with the PSQI global score as an indicator of overall sleep quality, and the goodness-of-fit indices for the adapted model were better compared to the original one-factor model. As expected, women, older adults, and patients with poor glycemic control had higher adapted PSQI global score ($p < 0.01$). Cronbach's α of the adapted PSQI was 0.78.

Conclusion: The adapted PSQI was similar to the original PSQI in that only the component "use of sleep medication" was removed from the original scale and the one-factor scoring worked better. In contrast, the three-factor model has limited usefulness in this population.

Keywords

Diabetes; Factor analysis; PSQI; Psychometric property; Sleep; Symptom

*Corresponding author. Dr. Bingqian Zhu, Department of Biobehavioral Health Science, College of Nursing, The University of Illinois at Chicago, 845S. Damen Ave., (MC 802), Chicago, IL 60612, USA, bzhu8@uic.edu (B. Zhu).

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

1. Introduction

Globally, one in 11 adults has diabetes; one person dies from diabetes every 6 s, resulting in 5.0 million deaths in 2015.[1] In China, the overall prevalence of diabetes in adults was estimated to be 11.6%.[2] Proliferating evidence suggests that sleep disturbance might play a role in the drastic increase in diabetes prevalence.[3,4] Diabetes alone is a leading cause of death, but when coupled with sleep disturbance poses even more severe threats to health. In people with type 2 diabetes (T2DM), the prevalence of sleep disturbance ranged from 55% to 71%.[5,6] Sleep disturbance, in turn, is correlated with poor glycemic control or quality of life.[5,7] Although the etiology of sleep disturbance in people with diabetes remains unclear, it is likely that diabetes-related pathophysiological changes could make the sleep in people with diabetes unique.

Sleep can be measured both objectively and subjectively. With the advancement of technology, polysomnography (PSG) and actigraphy are being widely used to measure objective sleep. However, their use is limited by intensive training, higher costs, and inability to assess subjective sleep. In contrast, Pittsburgh Sleep Quality Index (PSQI)[8] is a brief instrument that can be easily administered. Importantly, it assesses an individual's subjective perception of his/her sleep and complements with objective measurement of sleep, making the sleep assessment more comprehensive. To date, the PSQI remains the most commonly used instrument assessing subjective sleep disturbance.[9] The PSQI has been translated into multiple languages and validated in various populations. It evaluates seven conceptual domains of sleep, including sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction.

No consensus has been reached regarding the internal structure of the PSQI, although the one-factor model has been traditionally used by summing the seven components.[8] A recent systematic review examined current evidence in the factor structure of PSQI and found that the one-factor model performed poorly in most studies.[9] Particularly, Cole et al.[10] found that a three-factor structure of PSQI (i.e., sleep efficiency, perceived sleep quality, and daily disturbances) performed better than the original one-factor structure in older adults, suggesting the multidimensionality of sleep disturbance. Similarly, the three-factor structure also worked better in other populations.[11,12] It is possible that the one-factor model cannot capture the multidimensionality of the sleep disturbance in various populations. More interestingly, questions have been raised regarding the contribution of the component "use of sleep medication" to the scale across populations. Studies have reported low correlations between "use of sleep medication" and other components as well as the global score, and removing "use of sleep medication" has resulted in an improvement of the psychometric properties of the PSQI.[13,14]

Sleep disturbance in various populations likely has different attributes. Specifically, people with T2DM commonly undergo pathophysiological changes, including nocturia or neuropathic pain that could disturb their night sleep, making frequent awakenings a characteristic of sleep disturbance. Evaluation of the PSQI factor structure that is most relevant for T2DM patients is essential for our understanding of the sleep disturbance in this population. To our best knowledge, the factor structure of PSQI has not been examined in

the context of T2DM despite its wide use. Therefore, the objective of this study is to examine the factor structure of the PSQI in Chinese adults with T2DM. In this study, we evaluated whether the original one-factor,[8] the adapted one-factor (by removing "use of sleep medication"), or the three-factor[10] structure of the PSQI fits the sleep data in a sample of Chinese adults with T2DM. We provided further evidence for the validity of the factor solution by examining the relationships between the resultant factor and health-related indicators including age, gender, and glycemic control.

2. Methods

2.1. Participants

Data used in this report was from a cross-sectional study[15] aimed at investigating the relationship between sleep and glycemic control in people with T2DM. A convenience sample of 240 patients administered in the endocrinology unit in two general hospitals (Xi'an, Shaanxi, China) was recruited between September 2013 and January 2014. The sample size was determined *a priori*. The inclusion criteria were: 1) diagnosed with T2DM for over 1 year, as verified by the medical chart; 2) aged 18 or over; and 3) able to understand, read, and write in Chinese. Participants were excluded if they had medical chart confirmed: 1) gestational diabetes and other types of diabetes; 2) acute diabetic complications and severe heart, lung, and cerebral disease; or 3) mental illness or severe cognitive disorders.

2.2. Measures

2.2.1. Demographics and physiological parameters—Participant demographics were collected using a baseline questionnaire, which assesses participant age, gender, education, and marital status. Physiological parameters were collected from the patient record obtained while they were staying at the endocrinology unit, including height, weight, blood pressure, and A1C. According to the American Diabetes Association recommendation, A1C < 7% is considered good glycemic control.[16]

2.2.2. PSQI (Chinese version)—The PSQI was developed to evaluate subjective sleep disturbance over the past month by Buysse et al.[8] It consists of 19 self-rating items that can be categorized into seven components, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each component is scored on a 4-point Likert scale (0–3). The sum of the seven components results in a global score of 21. A high score indicates worse sleep quality. The PSQI (Chinese Version) was translated and validated by Liu et al. in a sample of college students and patients with insomnia or psychiatric diseases.[17] In that study, the internal consistency Cronbach's α was 0.84, the split-half reliability was 0.87, and the 2-week test-retest reliability was 0.81. The PSQI had a sensitivity of 98.3% specificity of 90.2% when the cutoff point was set at 8.

2.3. Procedures

The study was approved by the Institutional Review Board of a large Health Science Center in Midwestern of China. Written informed consent was obtained from all participants prior

to data collection. Participants completed the self-reported questionnaire in the paper-and-pencil format in their own ward. Data were checked immediately after completion, and further clarification from the participants was obtained to minimize missing data. Details about the recruitment and instrument administration were described in a previous paper.[15]

2.4. Data analysis

Data were entered into Epi Info 7.1 using a double-entry method. Stata 13.1 (College Station, Texas, USA) was used for statistical analysis. Statistical significance was assumed at two-tailed P values < 0.05 for all analyses. Data were analyzed with descriptive statistics ($\bar{x} \pm$ SD or percentage). Pearson correlation analyses were performed to examine the correlations among PSQI components and the global score. KMO and Bartlett' test were performed to measure the sampling adequacy for factor analysis. Confirmatory factor analysis (CFA) was conducted to examine the one-factor structure,[8] the adapted one-factor structure, and the three-factor structure.[10] The adapted global score was obtained by summing all component scores excluding "use of sleep medication." The three factors are sleep quality (reflected by subjective sleep quality, sleep latency, and sleep medication), daily disturbances (reflective by sleep disturbances and day-time dysfunction), and sleep efficiency (sleep duration and habitual sleep efficiency).[10]

The fit of the model was estimated with the Maximum Likelihood Algorithm based on the following indices:[18] χ^2 test estimating whether the actual model is different from the predicted one; comparative fit index (CFI) assessing the degree to which the model provides a better fit compared to no model at all; root mean square error of approximation (RMSEA) demonstrating the degree of misfit per degree of freedom; Bayesian information criterion (BIC) taking model parsimony into account; and standardized root mean square residual (SRMR).

The construct validity of the resultant model was further examined by using contrasted groups.[19] Gender and age have frequently been reported as factors affecting sleep quality.[20–22] Increasing evidence indicates that A1C is related to sleep disturbance.[7,23] Thus, whether the difference in PSQI score is significant between two gender groups, two age groups, and two glycemic control groups will be examined using t-test. Cronbach's α of the resultant model was obtained to evaluate its internal consistency. Among the 240 participants, 3 (1.3%) had a significant amount of missing data and therefore were excluded from the analysis. The final analysis included data from 237 participants.

3. Results

3.1. Descriptive statistics

The average age of the participants was 55.18 yrs and 32.9% were women. The mean A1C level was 8.72%, and only 22.8% maintained a good glycemic control recommended by American Diabetes Association (A1C < 7.0%).[16] The original PSQI global score was 8.04, and 44.3% of the participants had sleep disturbance (Table 1). The adapted PSQI global score was 7.88. Among all participants, only 15 (6.3%) reported "use of sleep medication" over the past month.

Correlations among the seven components, original PSQI global score, and adapted PSQI global score are shown in Table 2. When the original global score was used, the component-to-total correlations ranged from 0.42 to 0.80. The component-to-total correlations increased after the "use of sleep medication" was removed. Except correlations between sleep disturbances and "use of sleep medication" ($r = 0.12$, $p > 0.05$), daytime dysfunction and use of medication ($r = 0.05$, $p > 0.05$), the remaining component-to-component correlations were significant at $p < 0.01$. Sleep duration and habitual sleep efficiency had the highest correlation ($r = 0.65$).

3.2. Factor analysis

KMO (0.82) and Bartlett's test ($\chi^2 = 374.9$, df = 15, $p < 0.01$) suggested that factor analysis was suitable for this sample.[24] CFA was performed for the one-factor, adapted one-factor, and three-factor solutions. Table 3 shows the recommended and actual goodness-of-fit indices for the models. The results indicated that the adapted one-factor model had an adequate fit and performed better than the original one-factor model. In contrast, the three-factor model did not fit our data at all. Factor loading of the original and adapted one-factor model is shown in Figs. 1 and 2, respectively. In the original one-factor model, "use of sleep medication" had the lowest factor loading (0.30). In the adapted one-factor model, the standardized path coefficient ranged from 0.43 to 0.75, indicating appropriate loading.

3.3. Construct validity

As expected, women, older adults, and patients with poor glycemic control had higher adapted PSQI global score ($P < 0.01$) (Table 4), suggesting they had poorer sleep quality. This finding provided further evidence for the construct validity of the adapted PSQI.

3.4. Internal consistency reliability

The original PSQI had a Cronbach's α of 0.77, suggesting an adequate reliability. The adapted PSQI had α Cronbach's a of 0.78, which indicates that removing the component "use of sleep medication" did not influence the internal consistency of the PSQI.

4. Discussion

The purpose of this study is to examine the factor structure of the PSQI (Chinese version) in adults with T2DM through CFA. To our best knowledge, this study is among the first that examined the original one-factor, adapted one-factor, and three-factor model of the PSQI in the context of Chinese T2DM patients. We found that in people with T2DM, the adapted one-factor model (by removing "use of sleep medication") provided a scoring scheme that was more reflective of their response to the PSQI.

The consensus is yet to be reached regarding whether the one-factor is inferior/superior to the three-factor model. In our sample, the three-factor model fitted poorly to the data, which is inconsistent with findings from studies conducted in other populations such as breast cancer patients,[11] rheumatoid arthritis patients,[12] and college students.[25] Emerging evidence suggests that PSQI has a multidimensional structure. Theoretically, the multifactorial scoring systems have potential benefits. Cole and colleagues[10] suggested that the three-factor model

(i.e., sleep efficiency, perceived sleep quality, and daily dysfunctions) can fully capture various sleep-related problems, which helps to choose appropriate treatment regimen. In contrast, a global score derived from the one-factor structure might miss important aspects of sleep disturbance. Despite the theoretical support for a multifactorial scoring scheme, empirical evidence from our study still supports the one-factor structure, particularly the adapted model (removing "use of sleep medication"), in a diabetic population. Similarly, Rener-Sitar and colleagues also found a unidimensional structure of the PSQI in people with temporomandibular disorders.[26]

We found the adapted one-factor model of the PSQI is valid in measuring the sleep in adults with T2DM. In the present study, the correlations among PSQI component and the global score were moderate, with the exception of the component "use of sleep medication." These findings are consistent with previous findings.[12,14] In people with T2DM, diabetic complications, such as painful neuropathy, could interfere with their sleep quality, and thus the use of sleep medication could be high. Nevertheless, it is important to take cultural background into consideration regarding this aspect. In China, people usually do not seek help for sleep problems, and the complementary methods (e.g., Chinese herbs and acupuncture) are typically preferred over the over-the-counter sleep medications to relieve sleep problems.[27,28] That might explain the very low score on the "use of sleep medication" in this study (0.16 ± 0.64). Thus, it is possible that "use of sleep medication" in the PSQI did not fully capture the intended dimension in this particular population. It can also be argued that participants in this study did not have painful neuropathy, and therefore, the use of sleep medication was not frequent. That makes it difficult to identify sleep disturbances related to the "use of sleep medication". Nevertheless, as Nicassio and colleagues[12] have indicated that "use of sleep medication" may be a proxy of means to deal with sleep-related problems rather than an accurate indicator of sleep disturbance. Importantly, the factor loading of "use of sleep medication" was the lowest in this study, similar to previous findings,[26,29] which suggests a limited contribution of the "use of sleep medication" to the overall scale. In this study, the adapted one-factor model also showed an improvement in goodness-of-fit indices, which is in line with Becker and Jesus findings.[14]

Using contrasted group, we found that the adapted one-factor scoring of the PSQI was able to discriminate the sleep between men and women, older and younger adults, as well as people with good and poor glycemic control. In our study, women, older adults, and those with poor glycemic control had poorer sleep quality, consistent with previous findings.[7,30,31] These findings further support the construct validity of the adapted PSQI. The use of a global score of PSQI has inherent clinical significance. For example, women and older individuals might benefit more from intervention targeting sleep disturbance. The change in the global score can be easily used to evaluate the effectiveness of the intervention. Although the causal relationship between sleep and glycemic control in people with T2DM remains unclear, changes in the global PSQI score could potentially lead to changes in glycemic control or vice versa. In this regards, the simplicity of using a global score rather than multiple factor scores has important practical implications. In this study, the original PSQI global score associated highly with the adapted PSQI global score ($r = 0.99$, $P < 0.01$), and removing the component "use of sleep medication" did not compromise the internal

consistency of the PSQI. Instead, the Cronbach's α increased to 0.78 from the original 0.77. These findings are consistent with previous studies.[12–14]

Findings from this study need to be interpreted in the context of limitations. Although we examined the factor structure of the PSQI in a Chinese diabetic population, the generalizability of the findings is limited as a convenience sampling was used. Our study is limited in that the measurement invariance in subgroups was not investigated. Future studies exploring the dimensionality in subgroups (e.g., different gender, age category, and glycemic control) are recommended. Furthermore, whether the participants have neuropathic pain that can interfere with their sleep was not assessed. This might limit our ability to examine the component "use of sleep medication" thoroughly. Additionally, we did not examine the sensitivity and specificity of the adapted PSQI in identifying those with sleep disturbance. With the adaptation, a new cut-off point that helps to identify sleep disturbance should be examined in future studies.

Factor structure is an important part of validity, findings from this report provided more evidence for the psychometric property of the Chinese PSQI, which will facilitate its future use in the Chinese population. This study has significant implications for clinical practice and research. In people with diabetes, good sleep quality can reduce A1C by 0.35%, which can be translated to 3% and 5% reduction in death and microvascular complications, respectively.[7] The PSQI is a very short instrument that can be easily administered. In clinical practice, the adapted PSQI should regularly be administered to assess subjective sleep disturbance in people with diabetes. The one-factor scoring is recommended to identify those with sleep disturbance so that appropriate referral and intervention can be initiated. Meanwhile, the adapted PSQI holds great potential for future research in people with T2DM. It can be used for valid and reliable assessment of subjective sleep disturbance and its relationship with other health-related indicators (e.g., glycemic control). Nevertheless, studies are needed to further validate the adapted PSQI.

In conclusion, the factor structure of the PSQI, which is an important aspect of validity, was examined in this study. The adapted one-factor model of the PSQI (by removing "use of sleep medication") demonstrated an adequate validity and reliability. In conclusion, sleep disturbance in Chinese adults with T2DM is a unidimensional construct, as assessed by the adapted PSQI. The adapted PSQI was found to be valid and reliable in measuring subjective sleep disturbance in Chinese adults with T2DM.

References

1. International Diabetes Federation. Diabetes: facts and figures. 2015 Available at: http://www.idf.org/about-diabetes/facts-figures [accessed 01.12.16].
2. Xu Y, Wang L, He J, Bi Y, Li M, Wang T, et al. Prevalence and control of diabetes in Chinese adults. JAMA 2013;310:948–59. [PubMed: 24002281]
3. Anothaisintawee T, Reutrakul S, Van Cauter E, Thakkinstian A. Sleep disturbances compared to traditional risk factors for diabetes development: systematic review and meta-analysis. Sleep Med Rev 2016;30: 11–24. [PubMed: 26687279]
4. Shan Z, Ma H, Xie M, Yan P, Guo Y, Bao W, et al. Sleep duration and risk of type 2 diabetes: a meta-analysis of prospective studies. Diabetes Care 2015;38:529–37. [PubMed: 25715415]

5. Luyster FS, Dunbar-Jacob J. Sleep quality and quality of life in adults with type 2 diabetes. Diabetes Educ 2011;37:347–55. [PubMed: 21467248]
6. Knutson KL, Ryden AM, Mander BA, Van Cauter E. Role of sleep duration and quality in the risk and severity of type 2 diabetes mellitus. Arch Intern Med 2006;166:1768–74. [PubMed: 16983057]
7. Lee SW, Ng KY, Chin WK. The impact of sleep amount and sleep quality on glycemic control in type 2 diabetes: a systematic review and meta-analysis. Sleep Med Rev 2016;31:91–101. [PubMed: 26944909]
8. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pitts-burgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193–213. [PubMed: 2748771]
9. Mollayeva T, Thurairajah P, Burton K, Mollayeva S, Shapiro CM, Colantonio A. The Pittsburgh Sleep Quality Index as a screening tool for sleep dysfunction in clinical and non-clinical samples: a systematic review and meta-analysis. Sleep Med Rev 2016;25:52–73. [PubMed: 26163057]
10. Cole JC, Motivala SJ, Buysse DJ, Oxman MN, Levin MJ, Irwin MR. Validation of a 3-factor scoring model for the Pittsburgh Sleep Quality Index in older adults. Sleep 2006;29:112–6. [PubMed: 16453989]
11. Mariman A, Vogelaers D, Hanoulle I, Delesie L, Tobback E, Pevernagie D. Validation of the three-factor model of the PSQI in a large sample of chronic fatigue syndrome (CFS) patients. J Psychosom Res 2012;72:111–3. [PubMed: 22281451]
12. Nicassio PM, Ormseth SR, Custodio MK, Olmstead R, Weisman MH, Irwin MR. Confirmatory factor analysis of the Pittsburgh Sleep Quality Index in rheumatoid arthritis patients. Behav Sleep Med 2014; 12:1–12. [PubMed: 23390921]
13. Magee CA, Caputi P, Iverson DC, Huang X. An investigation of the dimensionality of the Pittsburgh Sleep Quality Index in Australian adults. Sleep Biol Rhythms 2008;6:222–7.
14. Becker NB, de Neves Jesus S. Adaptation of a 3-factor model for the Pittsburgh Sleep Quality Index in Portuguese older adults. Psychiatry Res 2017;251:298–303. [PubMed: 28236782]
15. Zhu B, Li X, Wang D, Yu X. Sleep quality and its impact on glycaemic control in patients with type 2 diabetes mellitus. Int J Nurs Sci 2014;1: 260–5.
16. American Diabetes Association. Standards of medical care in diabetes. Diabetes Care 2017:S48–56. [PubMed: 27979893]
17. Liu X, Tang M, Hu L. Reliability and validity of the Pittsburgh Sleep Quality Index. Chin J Psychiatry 1996;29:103–7.
18. Keith TZ. Analyzing path models using SEM programs. In: Keith TZ, editor. Multiple regression and beyond: an introduction to multiple regression and structural equation modeling. New York, NY: Routledge; 2014 p. 282–317.
19. DeVon HA, Block ME, Moyle-Wright P, Ernst DM, Hayden SJ, Lazzara DJ, et al. A psychometric toolbox for testing validity and reliability. J Nurs Scholarsh 2007;39:155–64. [PubMed: 17535316]
20. Arber S, Bote M, Meadows R. Gender and socio-economic patterning of self-reported sleep problems in Britain. Soc Sci Med 2009;68:281–9. [PubMed: 19026480]
21. Sherrill DL, Kotchou K, Quan SF. Association of physical activity and human sleep disorders. Arch Intern Med 1998;158:1894–8. [PubMed: 9759685]
22. Ohayon MM, Carskadon MA, Guilleminault C, Vitiello MV. Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: developing normative sleep values across the human lifespan. Sleep 2004;27:1255–74. [PubMed: 15586779]
23. Yoda K, Inaba M, Hamamoto K, Yoda M, Tsuda A, Mori K, et al. Association between poor glycemic control, impaired sleep quality, and increased arterial thickening in type 2 diabetic patients. PLoS ONE 2015; 10:e0122521. [PubMed: 25875738]
24. Tabachnick BG, Fidell LS. Principal components and factor analysis In: Tabachnick BG, Fidell LS, editors. Using multivariate statistics. Needham Heights, MA: Allyn & Bacon; 2001 p. 607–75.
25. Gelaye B, Lohsoonthorn V, Lertmeharit S, Pensuksan WC, Sanchez SE, Lemma S, et al. Construct validity and factor structure of the Pittsburgh Sleep Quality Index and Epworth Sleepiness scale in a multi-national study of African, South East Asian and South American college students. PLoS ONE 2014;9:e116383. [PubMed: 25551586]

26. Rener-Sitar K, John MT, Bandyopadhyay D, Howell MJ, Schiffman EL. Exploration of dimensionality and psychometric properties of the Pitts-burgh Sleep Quality Index in cases with temporomandibular disorders. Health Qual Life Outcomes 2014;12:1–10. [PubMed: 24382363]

27. Sarris J, Byrne GJ. A systematic review of insomnia and complementary medicine. Sleep Med Rev 2011;15:99–106. [PubMed: 20965131]

28. Liu Y, Zhang J, Lam SP, Yu MW, Li SX, Zhou J, et al. Help-seeking behaviors for insomnia in Hong Kong Chinese: a community-based study. Sleep Med 2016;21:106–13. [PubMed: 27448480]

29. Ho RTH, Fong TCT. Factor structure of the Chinese version of the Pittsburgh Sleep Quality Index in breast cancer patients. Sleep Med 2014; 15:565–9. [PubMed: 24759325]

30. Gupta S, Wang Z. Predictors of sleep disorders among patients with type 2 diabetes mellitus. Diabetes Metab Syndr 2016;10:213–20. [PubMed: 27377685]

31. Ramtahal R, Khan C, Maharaj-Khan K, Nallamothu S, Hinds A, Dhanoo A, et al. Prevalence of self-reported sleep duration and sleep habits in type 2 diabetes patients in South Trinidad. J Epidemiol Glob Health 2015;5:S35–43. [PubMed: 26073574]

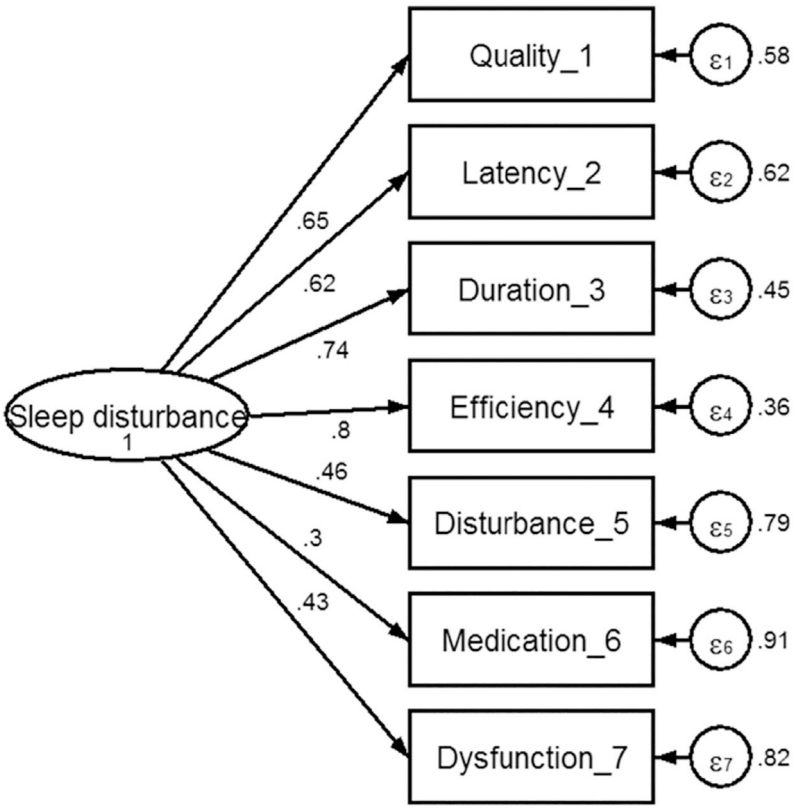

Fig. 1.
Factor loading of the original one-factor model.

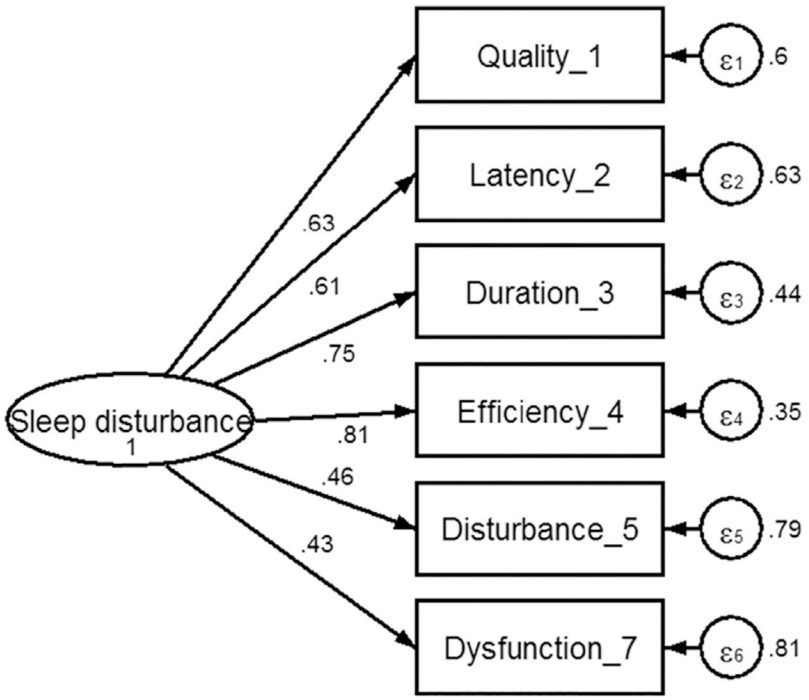

Fig. 2.
Factor loading of the adapted one-factor model.

Table 1

Participant characteristics (n = 237).

Variable	Mean ± SD or number (%)
Age (yrs)	55.18 ± 12.65
Older adults (≥65yrs)	54 (22.8)
Gender (female)	78 (32.9)
BMI (kg/m^2)	24.43 ± 3.53
Systolic pressure (mmHg)	133.5 ± 18.2
Diastolic pressure (mmHg)	79.6 ± 10.9
Diabetes duration (yrs)	8.49 ± 7.08
A1C (%)	8.72 ± 2.21
Good glycemic control (A1C < 7%)	54 (22.8)
Poor sleep quality (PSQI ≥ 8)	105 (44.3)
PSQI global score	8.04 ± 3.98
Adapted PSQI global score[a]	7.88 ± 3.76
1. Subjective sleep quality	1.30 ± 0.73
2. Sleep latency	1.45 ± 1.09
3. Sleep duration	1.04 ± 1.02
4. Habitual sleep efficiency	0.78 ± 1.05
5. Sleep disturbances	1.36 ± 0.52
6. Use of sleep medication	0.16 ± 0.64
7. Daytime dysfunction	1.94 ± 0.91

Note. BMI: body mass index; PSQI: Pittsburgh Sleep Quality Index.

[a]The adapted PSQI global score is the sum of all components excluding the “use of sleep medication”.

Table 2

PSQI component correlations.[a]

	Global	1	2	3	4	5	6	7
Global	1.00	0.72	0.73	0.76	0.80	0.53	0.42	0.57
Adapted global	0.99	0.71	0.73	0.77	0.81	0.54	NA	0.60
1. Subjective sleep quality		1.00	0.45	0.44	0.48	0.36	0.33	0.34
2. Sleep latency			1.00	0.43	0.47	0.28	0.27	0.28
3. Sleep duration				1.00	0.65	0.29	0.16	0.30
4. Habitual sleep efficiency					1.00	0.36	0.20	0.30
5. Sleep disturbances						1.00	***0.12***	0.30
6. Use of sleep medication							1.00	***0.05***
7. Daytime dysfunction								1.00

[a]All correlations are statistically significant at $P < 0.01$, except the two in ***bold and italic***. The adapted global score is the sum of all components excluding the “use of sleep medication”.

Table 3

Goodness-of-fit indices for the three models.

Model	χ^2-test *P*	CFI	RMSEA	BIC	SRMR
Recommended value	>0.05	>0.95	<0.05	Lower value	<0.06
One-factor[a]	<0.01	0.94	0.083	3788.75	0.045
Adapted one-factor[b]	0.02	0.97	0.074	3331.80	0.037
Three-factor[c]	NA	1.00	NA	3967.57	0.244

[a]A one-factor model by summing all seven components.

[b]An adapted one-factor model by summing all components excluding the “use of sleep medication”.

[c]A three-factor model consisting of sleep quality, daily disturbances, and sleep efficiency.

Table 4

Construct validity of the adapted PSQI using contrasted groups.

	Gender		Age		Glycemic control	
	Female	**Male**	**≥65 yrs**	**<65 yrs**	**≥7%**	**<7%**
Mean	9.1 ± 3.9	7.3 ± 3.5	9.4 ± 3.9	7.4 ± 3.6	8.8 ± 3.6	4.9 ± 2.3
t	−3.7		−3.6		7.5	
p	<0.01		<0.01		<0.01	