Factor Analysis of the Insomnia Severity Index and Epworth Sleepiness Scale in Shift Workers

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ABSTRACT

Background: Over one million Korean night shift workers undergo clinical assessment of sleep using the Insomnia Severity Index (ISI) and Epworth Sleepiness Scale (ESS) by occupational medical examination each year. Therefore, this study was conducted to evaluate the reliability and validity of the ISI and ESS using occupational medical examination data.

Methods: The study subjects included 12,056 shift workers at an electronics company who underwent an occupational health examination about shift work in 2018. The evaluation of the ISI and ESS was performed using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA).

Results: According to the results of the EFA, the ISI had a single-factor structure, while the ESS had a two-factor structure, which was inconsistent with the findings of previous studies. The results of the EFA of 15 items from the combined ISI and ESS suggested a three-factor structure, with one factor for ISI items and two factors for ESS items, while the results of the CFA suggested sufficient validity of the combination of the ISI and ESS for sleep evaluation.

Conclusion: The results suggest that the ISI and ESS have sufficient reliability and validity to be used for occupational health examinations about shift work.

Keywords: Shift Work; Factor Analysis; ISI; ESS; Occupational Health Exam

INTRODUCTION

There has been a remarkable increase in the number of shift workers worldwide, including Korea, due to changes in the industrial structure and growth of the service industry in recent decades. The negative health effects of shift work have been extensively investigated. Shift work has been found to be closely associated with the incidence of various chronic diseases, including hypertension, stroke, myocardial infarction, and diabetes; in particular, sleep difficulty in shift workers has been demonstrated in a systematic review and is considered to be the most important health issue for these workers. Shift work is a direct cause of circadian rhythm disruption; therefore, shift work disorder is a subtype of circadian rhythm disruption.
In other words, shift workers have difficulty sleeping because they have to work at times that do not fit their physiological or social circadian rhythms. As a result, job stress and accident risks increase, which leads to increased mortality. However, because shift work is considered an irreplaceable form of work in industries with a high degree of division of labor, the need for sleep management is growing.

Korean workers who handle hazardous materials including 162 chemical factors (organic compounds, metals, acids, and alkalis), 7 dust factors (grain dust, mineral dust, cotton dust, wood dust, welding fumes, glass fiber dust, and asbestos) and 9 physical factors (noise, vibration, radiation, high pressure, low pressure, and ultraviolet, infrared, micro and radio waves), are required to undergo occupational health examinations periodically as per the Occupational Safety and Health Act. In particular, a special screening for shift workers, to be conducted by occupational health physicians, was newly added in 2014. For this, the shift workers must meet one of the following two criteria: 1) an 8-hour work shift (that must include the interval from 12 to 5 am) four or more times a month for six consecutive months, and 2) at least 60 average monthly hours spent working from 10 pm to 6 am for six consecutive months. The first round of screening includes assessment of the Insomnia Severity Index (ISI), abdominal circumference, blood pressure, fasting blood sugar, total cholesterol, triglycerides, high-density lipoprotein (HDL) cholesterol, and gastrointestinal-related symptoms, as well as questions regarding breast cancer-related symptoms. In the second round of screening, the examinees are followed up on the areas that showed abnormalities in the first screening using one or multiple tests, such as the Epworth Sleepiness Scale (ESS), the Pittsburgh Sleep Quality Index (PSQI), blood pressure, fasting blood glucose, glycosylated hemoglobin, total cholesterol, triglyceride, HDL cholesterol, LDL cholesterol, 24-hour ECG, 24-hour blood pressure, gastroscopy, breast imaging, and breast ultrasound. In general, the test examinees are required to complete all three sleep questionnaires during screening: the ISI, ESS, and PSQI.

Insomnia is the most common sleep disorder with a prevalence of 9%–30% in the general population. The ISI is a 7-item self-reported instrument that measures the patient’s perception of insomnia severity. The ESS was developed to measure “daytime sleepiness” in adults. Daytime sleepiness refers to an individual’s average sleep tendency during the day. The ESS is the most widely used tool for measuring daytime sleepiness for clinical and research purposes.

The validity of the ISI has been demonstrated in various populations, including patients with cancer, older adults, and outpatients. The validity of the ESS has also been demonstrated within populations, such as patients with sleep apnea syndrome and elderly people. The ESS and ISI scores of shift workers were found to be different from those of day workers. However, none of these studies have evaluated the validity of both the ISI and ESS in shift workers. The PSQI was not included in the present study because the type and content of its questions are different from those of the ISI and ESS. The ISI and ESS continue to be used for the sleep evaluation of a substantial number of Korean shift workers. More than a million shift workers have undergone occupational health examinations for shift work, and the number is increasing. Thus, annually over a million shift workers are evaluated using the ISI and ESS, and the social cost is approximately 40 billion won. Therefore, this study about the validity of the ISI and ESS based on large-scale health screening data from shift workers is very important.
METHODS

Subjects
This study included 12,056 shift workers at an electronics company that conducted occupational health examinations for these workers in 2018. Subjects completed the sleep questionnaires offline or online.

Measures
The Korean version of the ISI was used to assess the subjective severity of insomnia,24 The ISI consists of seven items on a five-point Likert scale (0–4) with a total score between 0 and 28.11 The Korean version of the ESS was used to assess daytime sleepiness.16 The ESS comprises eight items on a four-point Likert scale (0–3) with a total score between 0 and 32.13

Statistical analysis
The reliability of the ISI and ESS was evaluated by estimating internal consistency using Cronbach’s alpha. The factorial validity of the ISI and ESS was assessed using exploratory factor analysis (EFA; principal axis factoring) with promax rotation. The number of factors was determined based on eigenvalues (> 1), which represents the variance explained by each factor, as well as the coherence and interpretability of the factors. The factors that were identified by the EFA were tested using confirmatory factor analysis (CFA). Model fit was evaluated using criteria based on fit indices, such as RMR < 0.05, GFI > 0.90, RMSEA < 0.08, NFI > 0.9 and AGFI > 0.90.25 All analyses were conducted with PASW Statistics for Windows, Version 18.0 and AMOS 18.0 (IBM Co., New York, NY, USA).

Ethics statement
The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Kangbuk Samsung Hospital (IRB approval No.2019-06-022). Because only anonymous data with no identifiable personal information were used, prior consent was waived for the participants.

RESULTS

Overall, 43.7% of the subjects were women, and 56.3% were men. The overall mean age was 28.75 ± 8.26. The mean ages of the women and men were 28.58 ± 7.98 and 28.89 ± 8.47 years, respectively. The men were significantly older than the women (P = 0.042).

The mean ISI and ESS scores were 11.88 ± 4.42 and 13.76 ± 3.46, respectively. The prevalence of insomnia was 25.0% when the cutoff value was set at 15.26 The share of those with more than 9 points on the ESS was 89.4%.27 The values of Cronbach’s alpha for the ISI and ESS were 0.888 and 0.817, respectively, suggesting that both tests have sufficient internal consistency. The item-total correlations of the ISI and ESS ranged from 0.41 to 0.71 (mean, 0.54) and from 0.20 to 0.55 (mean, 0.36), respectively.

Principal component analysis found only one factor in the ISI with eigenvalues > 1. Factor 1 accounted for 60.3% of the variance. The Kaiser-Meyer-Olkin value (0.876) and the results of Barrett’s test of sphericity (P < 0.001) indicated that the factor structure was appropriate (Table 1).

Principal component analysis with promax rotation found 2 factors in the ESS with eigenvalues > 1. The same number of factors was indicated by the scree plot. Factor 1
accounted for 44.4% of the variance and comprised lying down, car passenger, sitting quietly, and sitting reading. Factor 2 accounted for 12.9% of the variance and comprised sitting talking, watching TV, car in traffic, and sitting in public. The Kaiser-Meyer-Olkin value (0.857) and the results of Barrett’s test of sphericity ($\chi^2 < 0.001$) indicated that the factor structure was appropriate (Table 2).

Principal component analysis with promax rotation found 3 factors in the combined ISI and ESS of 15 items with eigenvalues > 1. The same number of factors was indicated by the scree plot. Factor 1 accounted for 36.5% of the variance and comprised 7 items of the ISI. Factor 2 accounted for 15.7% of the variance and comprised lying down, car passenger, and sitting quietly. Factor 3 accounted for 6.9% of the variance and comprised sitting talking, watching TV, car in traffic, sitting in public, and sitting reading. The Kaiser-Meyer-Olkin value (0.895) and the results of Barrett’s test of sphericity ($\chi^2 < 0.001$) indicated that the factor structure was appropriate (Table 3).

The correlations between three factors of the ISI and ESS were significant at 0.285, 0.398, and 0.573 ($\chi^2 < 0.01$) (Table 4).

The fit indices indicated a good model fit (RMR, 0.027; GFI, 0.902; and RMSEA, 0.079). The values of the AGFI and NFI were less than 0.9 (0.864 and 0.888, respectively) yet were similar to each other. All three absolute fit indices, RMR, GFI, and RMSEA, met the appropriate criteria, suggesting that the model fit is acceptable.
The validity of the combination of the ISI and ESS measures was evaluated based on coefficients for construct, convergent, and discriminant validity. The standardized coefficients for observed variables comprising Factors 1, 2, and 3 ranged from 0.535 to 0.803, thereby exceeding the criterion of 0.5 and suggesting that the combined measure has sufficient construct validity (Fig. 1). The average variance extracted (AVE), used to estimate convergent validity, for the three factors was 0.636, 0.638, and 0.653, exceeding the criterion of 0.5. The construct reliability coefficients were 0.924, 0.840, and 0.903, exceeding the criterion of 0.7, and suggesting that the combined measure has sufficient convergent validity (Table 5).

The squared correlation coefficients between the individual factors were 0.120, 0.239, and 0.554, which were lower than the AVEs for individual factors and suggested that the combined measure had sufficient discriminant validity (Table 6).

**DISCUSSION**

Factor analysis is a good method to evaluate the validity of questionnaires. The study findings suggest that the ISI and ESS are reliable and valid instruments for sleep evaluation in shift workers. In particular, the results of the factor analysis of the combination of the ISI and ESS measures, including the identification of three factors, one factor for the ISI items and two factors for the ESS items, and sufficient levels of validity in varying subtypes, justify the use of the two measures for occupational health examination in shift workers.
In our study, the mean ISI and ESS scores were 11.88 and 13.76, respectively, which are far higher than those in healthy Korean adults and in the general population in other countries. As expected, the overall sleep conditions of shift workers were poor.

### Table 5. Validity of confirmatory factor analysis of the ISI and ESS

| Factors | Standardized estimates | AVE (variance extracted index) | CR |
|---------|------------------------|-------------------------------|----|
| Factor 1 → ISI |                         | 0.636                        | 0.924 |
| Factor 1 → ISI 2 |                      | 0.766                        | |
| Factor 1 → ISI 7 |                      | 0.803                        | |
| Factor 1 → ISI 5 |                      | 0.768                        | |
| Factor 1 → ISI 1 |                      | 0.721                        | |
| Factor 1 → ISI 3 |                      | 0.690                        | |
| Factor 1 → ISI 4 |                      | 0.701                        | |
| Factor 1 → ISI 6 |                      | 0.678                        | |
| Factor 2 → ESS |                         | 0.638                        | 0.840 |
| Factor 2 → ESS 7 |                      | 0.706                        | |
| Factor 2 → ESS 4 |                      | 0.673                        | |
| Factor 2 → ESS 5 |                      | 0.758                        | |
| Factor 3 → ESS |                         | 0.653                        | 0.903 |
| Factor 3 → ESS 1 |                      | 0.649                        | |
| Factor 3 → ESS 3 |                      | 0.668                        | |
| Factor 3 → ESS 8 |                      | 0.550                        | |
| Factor 3 → ESS 2 |                      | 0.661                        | |
| Factor 3 → ESS 6 |                      | 0.535                        | |

ISI = insomnia severity index, ESS = Epworth sleepiness scale, AVE = average variance extracted, CR = construct reliability.
Previous studies on the factor structure of the ISI have yielded varied and inconsistent findings. A previous study of patients with insomnia identified three factors, night-time sleep difficulties, sleep dissatisfaction, and daytime impact of insomnia, which explained 72% of the total variance. The ISI score in a study composed of insomnia patients was 19.7. A study of patients with breast or prostate cancer presented two factors, night-time sleep difficulties and daytime impact of insomnia, which explained approximately 60% of the total variance. The ISI score of that prior study was 7.3.

A study of older adults aged 56–87 demonstrated that a single factor explained 69% of the total variance. The mean age in that previous study was 71 years. A study of adolescents demonstrated that two factors explained 65.6% of the total variance. The ISI score of that study was 7.4, and the study subjects were 11–20 years old. A study of the general population demonstrated three factors. The ISI score of that study was 9.1, and the study subjects were recruited from schools, communities and hospitals. A study of university students and police officers demonstrated a single factor structure. The ISI scores of the university students and police officers were 6.56 and 6.98.

In the present study of shift workers, the ISI was found to have a single-factor structure. The mean age and ISI score were 29 years and 11.88, respectively. The mean ISI score was higher for shift workers than for day workers, and higher subjective insomnia was associated with various health problems in shift workers.

The ISI score of shift workers in this study was higher than that in other studies, including university students and young workers, except for insomnia patients. The subjects of this study consisted of only shift workers from a large electronics company. It is believed that the homogeneity of the working condition of subjects showed a single factor structure.

The ESS is a questionnaire designed to evaluate patients’ habitual sleepiness during the day, and is used worldwide. Other EFA studies on the ESS factor structure have shown a single-factor structure. The ESS scores of patients who visited the daytime sleepiness clinic, patients with a variety of sleep disorders, patients with sleep apnea and medical students were 10.5, 10.2, 12.1 and 7.6. The ESS score of this study was 13.8, which is higher than that in previous studies. In contrast, the present study found a two-factor structure in which items 1, 4, 5, and 7 and items 2, 3, 6, and 8 formed factor structures. Item 1 had nearly equal loading on Factors 1 and 2. Factor 1 included lying down, car passenger, and sitting quietly, indicating resting without engaging in a particular activity. The variance explained by Factor 1 was 52.232%, accounting for most of the total variance (59.097%). Factor 2 included sitting talking, watching TV, car in traffic, and sitting in public, which can be summarized...
as engaging in a particular activity, such as watching something, talking, and driving. Shift
workers were found to have greater daytime sleepiness and higher ESS scores than patients
with sleep disorders in the present study. Generally shift workers experienced excessive
daytime sleepiness more often than the general population too. This due to the changes
in circadian rhythms and sleep patterns associated with shift work. Daytime sleepiness
of shift workers is associated with decreased concentration, which increases the risk of
accidents. Because of the excessive daytime sleepiness and decreased concentration of shift
workers, the difference in daytime sleepiness between sitting quietly and doing something is
much larger in shift workers than in the general population. Due to this characteristic of shift
workers, the ESS showed a two-factor structure, unlike in previous studies.

Over 2 million workers underwent occupational health examinations in Korea in 2017.
Approximately 1.05 million of them underwent occupational health examinations for shift
work, and the number increases annually. Annually, over a million shift workers have been
evaluated for sleep problems using the ISI, ESS, and PSQI in Korea. Based on the results,
workers assessed as being in poor condition receive counseling and are sometimes referred
to a psychiatric outpatient unit. Despite of the importance of these measures and the need to
establish their use as measures for sleep evaluation, research aiming to validate the ISS and
ESS for shift workers has been scarce; hence, our study particularly focuses on this area.

In the present study, a novel attempt was made to evaluate the potential of the sleep
questionnaires used for the occupational health examination of shift workers by performing
a factor analysis of the combined ISI and ESS measures. A previous study using factor
analysis of the combined two measures represented good results. The EFA results for the
combined measure were nearly identical to those obtained for the ISI and ESS individually.
The 15 items of the combined ISI and ESS measures were classified into three factors: Factor
1, comprising seven ISI items; Factor 2, comprising three ESS items (sitting quietly); and
Factor 3, comprising five ESS items (sitting and doing something). The variance explained
by the three factors was 59.097%, indicating excellent explanatory power. The CFA also
yielded results that met the criteria for construct, convergent, and discriminant validity,
along with the standardized estimates between individual factors and items in the range of
0.54–0.80, which indicates sufficient explanatory power. (Tables 5 and 6) In summary, the
sleep measures used for the occupational health examination of shift workers have sufficient
validity and comprise appropriate items.

There are some limitations in the present study. The subjects are from one large electronics
company and there is no data about the type of work. There are various types of shift work
schedules including evening shift, night shift, regular day and night shift, 24 hours shift and
others. To represent all shift workers, it is necessary to study various types of companies,
occupations and shift work schedules. The study is also limited by the inability to compare
with day workers because there is no control group of day workers who took the ISI and ESS.
However, this subject sample contains more than 10 thousand individuals, representing
approximately 1% of all Korean shift workers, and the sample size is meaningful.

The difference between the factors identified in this study and those in previous studies
is likely due to the high risk of sleep disorders in shift workers. Future studies may include
comparative analyses with additional variables, such as the type and duration of shift work
and the gender of workers, to generate sufficient data to develop strategies to manage and
treat shift work sleep disorders. This study provides evidence of the validity and reliability
of the ISS and ESS instruments used to evaluate sleep disorders in shift workers, thereby providing a foundation for future research in this field.

REFERENCES

1. Bae MJ, Song YM, Shin JY, Choi BY, Keum JH, Lee EA. the association between shift work and health behavior: findings from the Korean National Health and Nutrition Examination Survey. *Korean J Fam Med* 2017;38(2):86-92. PUBMED | CROSSREF

2. Gan Y, Yang C, Tong X, Sun H, Cong Y, Yin X, et al. Shift work and diabetes mellitus: a meta-analysis of observational studies. *Occup Environ Med* 2015;72(1):72-8. PUBMED | CROSSREF

3. Vyas MV, Garg AX, Iansavichus AV, Costella J, Donner A, Laugsand LE, et al. Shift work and vascular events: systematic review and meta-analysis. *BMJ* 2012;345:e4800. PUBMED | CROSSREF

4. Booker LA, Magee M, Rajaratnam SM, Sletten TL, Howard ME. Individual vulnerability to insomnia, excessive sleepiness and shift work disorder amongst healthcare shift workers. A systematic review. *Sleep Med Rev* 2018;41:220-33. PUBMED | CROSSREF

5. Sateia MJ. International classification of sleep disorders-third edition: highlights and modifications. *Chest* 2014;146(5):1387-94. PUBMED | CROSSREF

6. Park H, Sub B, Lee SI. Shift work and depressive symptoms: the mediating effect of vitamin D and sleep quality. *Chronobiol Int* 2019;36(5):689-97. PUBMED | CROSSREF

7. Dawson D, Ian Noy Y, Härnä M, Akerstedt T, Belenky G. Modelling fatigue and the use of fatigue models in work settings. *Accid Anal Prev* 2011;43(2):549-64. PUBMED | CROSSREF

8. Akerstedt T, Fredlund P, Gillberg M, Jansson B. A prospective study of fatal occupational accidents -- relationship to sleeping difficulties and occupational factors. *J Sleep Res* 2002;11(1):69-71. PUBMED | CROSSREF

9. Hale HB, Williams EW, Smith BN, Melton CE Jr. Neuroendocrine and metabolic responses to intermittent night shift work. *Aerosp Med* 1971.42(2):156-62. PUBMED

10. National Institutes of Health. National Institutes of Health State of the Science Conference statement on manifestations and management of chronic insomnia in adults, June 13-15, 2005. *Sleep* 2005;28(9):1049-57. PUBMED

11. Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Med* 2001;2(4):297-307. PUBMED | CROSSREF

12. Fernandez-Mendoza J, Rodríguez-Muñoz A, Vela-Bueno A, Olavarrieta-Bernardino S, Calhoun SL, Bidder EO, et al. The Spanish version of the Insomnia Severity Index: a confirmatory factor analysis. *Sleep Med* 2012;13(2):207-10. PUBMED | CROSSREF

13. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep* 1991;14(6):540-5. PUBMED | CROSSREF

14. Johns MW. A new perspective on sleepiness. *Sleep Biol Rhythms* 2010;8(3):170-9. CROSSREF

15. Sargento P, Perea V, Ladera V, Lopes P, Oliveira J. The Epworth Sleepiness Scale in Portuguese adults: from classical measurement theory to Rasch model analysis. *Sleep Breath* 2015;19(2):693-701. PUBMED | CROSSREF

16. Cho YW, Lee HJ, Son HK, Lee SH, Shin C, Johns MW. The reliability and validity of the Korean version of the Epworth sleepiness scale. *Sleep Breath* 2011;15(3):377-84. PUBMED | CROSSREF
17. Savard MH, Savard J, Simard S, Ivers H. Empirical validation of the Insomnia Severity Index in cancer patients. *Psychooncology* 2005;14(6):429-41.

18. Sierra JC, Guillén-Serrano V, Santos-Iglesias P. Insomnia Severity Index: some indicators about its reliability and validity on an older adults sample. *Rev Neurol* 2008;47(11):566-70.

19. Gagnon C, Bélanger L, Ivers H, Morin CM. Validation of the Insomnia Severity Index in primary care. *J Am Board Fam Med* 2013;26(6):701-10.

20. Chiner E, Arriero JM, Signes-Costa J, Marco J, Fuentes I. Validation of the Spanish version of the Epworth sleepiness scale in patients with a sleep apnea syndrome. *Arch Bronconeumol* 1999;35(9):422-7.

21. Spica AP, Beaudreau SA, Stone KL, Kezirian EJ, Lui LY, Redline S, et al. Reliability and validity of the Pittsburgh sleep quality index and the Epworth sleepiness scale in older men. *J Gerontol A Biol Sci Med Sci* 2012;67(4):433-9.

22. Vallières A, Azaiez A, Moreau V, LeBlanc M, Morin CM. Insomnia in shift work. *Sleep Med* 2014;15(12):1440-8.

23. Ministry of Employment and Labor (KR). Results of health examination for workers in 2017. https://www.moel.go.kr/info/publicdata/majorpublish/majorPublishView.do?bbs_seq=20181200871. Updated 2018. Accessed Jun 9, 2019.

24. Cho YW, Song ML, Morin CM. Validation of a Korean version of the insomnia severity index. *J Clin Neurol* 2014;10(3):210-5.

25. Hooper D, Coughlan J, Mullen M. Structural equation modelling: guidelines for determining model fit. *J Bus Res Methods* 2008;6(1):53-60.

26. Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Med* 2001;2(4):297-307.

27. Johns MW. Reliability and factor analysis of the Epworth Sleepiness Scale. *Sleep* 1992;15(4):376-81.

28. Hair JF. *Multivariate Data Analysis*. 6th ed. New Delhi: Pearson Education; 2009.

29. Choi CH, You YY. The study on comparative analysis of the same data through regression analysis model and structural equation model. *J Digit Converg* 2016;14(6):167-75.

30. Hong SW, Gong HS, Park JW, Roh YH, Baek GH. Validity, reliability and responsiveness of the Korean version of quick disabilities of the arm, shoulder, and hand questionnaire in patients with carpal tunnel syndrome. *J Korean Med Sci* 2018;33(40):e249.

31. Sohn SI, Kim DH, Lee MY, Cho YW. The reliability and validity of the Korean version of the Pittsburgh Sleep Quality Index. *Sleep Breath* 2012;16(3):803-12.

32. Morin CM, Bélanger L, LeBlanc M, Ivers H, Espie CA, et al. The natural history of insomnia: a population-based 3-year longitudinal study. *Arch Intern Med* 2009;169(5):447-53.

33. Chung KF, Kan KK, Yeung WF. Assessing insomnia in adolescents: comparison of insomnia severity index, Athens insomnia scale and sleep quality index. *Sleep Med* 2011;12(5):463-70.

34. Chen PY, Yang CM, Morin CM. Validating the cross-cultural factor structure and invariance property of the insomnia severity index: evidence based on ordinal EFA and CFA. *Sleep Med* 2015;16(5):598-603.

35. Gerber M, Lang C, Lemola S, Colledge F, Kalak N, Holsboer-Trachsler E, et al. Validation of the German version of the insomnia severity index in adolescents, young adults and adult workers: results from three cross-sectional studies. *BMC Psychiatry* 2016;16(1):174.
37. Vallières A, Azaiez A, Moreau V, LeBlanc M, Morin CM. Insomnia in shift work. *Sleep Med* 2014;15(12):1440-8.

38. Chen NH, Johns MW, Li HY, Chu CC, Liang SC, Shu YH, et al. Validation of a Chinese version of the Epworth sleepiness scale. *Qual Life Res* 2002;11(8):817-21.

39. Johns MW. Sleepiness in different situations measured by the Epworth sleepiness scale. *Sleep* 1994;17(8):703-10.

40. Kingshott R, Douglas N, Deary I. Mokken scaling of the Epworth sleepiness scale items in patients with the sleep apnoea/hypopnoea syndrome. *J Sleep Res* 1998;7(4):293-4.

41. Johns MW. Reliability and factor analysis of the Epworth sleepiness scale. *Sleep* 1992;15(4):376-81.

42. Ohayon MM, Lemoine P, Arnaud-Briant V, Dreyfus M. Prevalence and consequences of sleep disorders in a shift worker population. *J Psychosom Res* 2002;53(1):577-83.

43. Pagel JF. Excessive daytime sleepiness. *Am Fam Physician* 2009;79(5):391-6.

44. Drake CL, Roehrs T, Richardson G, Walsh JK, Roth T. Shift work sleep disorder: prevalence and consequences beyond that of symptomatic day workers. *Sleep* 2004;27(8):1453-62.

45. Suzuki K, Ohida T, Kaneita Y, Yokoyama E, Uchiyama M. Daytime sleepiness, sleep habits and occupational accidents among hospital nurses. *J Adv Nurs* 2005;52(4):445-53.

46. Lee K, Kim D, Cho Y. Exploratory factor analysis of the Beck anxiety inventory and the Beck depression inventory-II in a psychiatric outpatient population. *J Korean Med Sci* 2018;33(16):e128.