**Original Article**

# Sleep Quality and Related Determinants among Stroke Patients: A Cross-Sectional Study

**Salman Khazaei[1], Erfan Ayubi[2], Mahdi Khazaei[3], Mojtaba Khazaei[4*], Gita Afrookhteh[5]**

**Abstract**

**Objective:** Effective rehabilitation and better quality of life among stroke patients are functions of several factors such as quality and pattern of sleep. The present study aimed to evaluate sleep quality and related determinants in such patients.
**Method:** The present cross-sectional study was performed from October to December 2019 among stroke patients who were admitted to Sina Hospital, Hamadan, Iran. We used the Pittsburgh Sleep Quality Index (PSQI) questionnaire to determine sleep quality in these patients. Significant determinants of the global score of PSQI were identified via multivariable linear regression.
**Results:** A total of 97 stroke patients (age 67±79 years, 55.7% male) were enrolled into the study. Prevalence of poor sleep was 0.84 (95% CI: 0.75, 0.91) in stroke patients. Patients with nervous tension and those with surgical treatment and with Non-hemorrhagic CT scan had a predicted increase of 1.65, 2.91 and 3.25 in the mean of the global PSQI score (P ≤ 0.05), respectively.
**Conclusion:** Nervous tension, treatment method, results of CT scan and cardiac problems may be associated with post-stroke sleep disorder.

**Key words:** *Risk Factors; Sleep Disorder; Stroke*

**1.** Research Center for Health Sciences, Hamadan University of Medical Sciences, Hamadan, Iran.
**2.** Social Determinants of Health Research Center, Hamadan University of Medical Sciences, Hamadan, Iran.
**3.** Student Research Committee, Hamadan University of Medical Sciences, Hamadan, Iran.
**4.** Department of Neurology, School of Medicine, Hamadan University of Medical Sciences, Hamadan, Iran.
**5.** Department of Psychiatry, Hamadan University of Medical Sciences, Hamadan, Iran.

**\*Corresponding Author:**
Address: Department of Neurology, School of Medicine, Hamadan University of Medical Sciences, Postal Code: 6517838678.
Tel: 98-81 32640062, Fax: 98-81 38380130, Email: khazaeimojtaba@yahoo.com

Stroke is a state of acute disorder of cerebral circulation that in this disorder occurred transient or permanent brain dysfunction. According to the type of pathological process, stroke is divided into hemorrhagic and ischemic (1). It is the most common neurological disorder, the second and third cause of disability and death, respectively. Nearly 30 to 40 percent of survivors also face widespread complications and disabilities that lead to major lifestyle changes (2, 3).

Patients with stroke often complain of complex brain symptoms including memory impairment, inability to concentrate, instability in emotion, increased need for sleep, and fatigue (4). Many of these complaints are associated with sleep disorders in stroke patients (1). In fact, stroke has a profound effect on the persistence and structure of sleep, because most of the anatomical structures of sleep are located in the central nervous system (5, 6). A wide range of sleep disorders occur in patients with stroke, insomnia being one of the most common and also in more than half of patients with obstructive sleep apnea (7, 8). All of these observed sleep disorders are associated with poor functional outcomes and reduced quality of life in these patients (9). However, sleep changes in these patients may be partially related to brain tissue damage and other factors including acute changes in sleep environment, physical and mental stress, increased bed rest, fever, medications, pain, and other systemic disorders affecting sleep parameters. These changes have also been measured in patients with myocardial infarction and similar results have been reported (10, 11).

There is still no consensus on the pattern of sleep disorders in these patients. Increasing awareness regarding sleep disorders in stroke patients is essential to provide more effective rehabilitation and to improve stroke outcomes and, subsequently, quality of life. Therefore, we decided to investigate status of sleep disorders and its predictors in stroke patients.

## Materials and Methods

### Study design and setting
The present cross-sectional study was conducted on 97 stroke patients admitted to Sina Hospital, affiliated to Hamadan University of Medical Sciences, as a referral center from October to December 2019. Convenience sampling method was used for choosing patients.

### Eligibility criteria
Inclusion criteria: 1) At least one month has passed since the patient's stroke; 2) Verified CVA detection; 3) Not taking medications related to sleep disorders; 4) No sleep-related illnesses including narcolepsy, cataplexy and obstructive sleep apnea; 5) The patient's GCS is over 14; 6) The lesion is not in the frontal lobe; 7) The patient does not have delirium.

Exclusion criteria: 1) Unwillingness to participate in the study; 2) Inability to answer the questionnaire questions; 3) Aphasic patients.

All participants completed the written consent and accepted to take part in this study. Ethical approval of the study was obtained by the Medical Ethics Committee of Hamadan University of Medical Sciences (IR.UMSHA.REC.1398.550).

### Measurement tool
The demographic and clinical characteristics of patients included: sex, residence, blood disorder, hypertension, blood sugar, metabolic disorder, smoking, blood lipid, nervous tension, CT scan results, final diagnosis, treatment method, immobility, urinary problem, vision problem, hearing problem, respiratory problem and cardiac problem gathered through a checklist designed for this research. The Pittsburgh Sleep Quality Index (PSQI) was used to determine sleep quality in stroke patients. PSQI quantifies patients' sleep quality in seven domains: 1) subjective sleep quality, 2) sleep latency, 3) sleep duration, 4) sleep efficiency, 5) sleep disturbance, 6) sleep medication use, 7) daytime dysfunction and finally the global PSQI score (12). Reliability and validity of this questionnaire was approved in Iran (13).

### Statistical analyses
Descriptive statistics were reported as numbers (%) across participant's background and risk factors of stroke. A univariate linear regression analysis was performed to screen potentially significant determinants of the global score of PSQI. Participant's background and risk factors for stroke were entered in the univariate linear regression as explanatory predictors. Those with P < 0.20 in the univariate analyses were considered for multivariable analyses. Multicollinearity was tested using variance inflation factors (VIF). VIF of above 10 is sign of Multicollinearity that can lead to inflation of variance and uncertainty in the resulting effect measures and VIF of 1 means that there is no Multicollinearity among variables in the regression model. Bootstrapping with 1000 resample was performed to check internal validity of developed multivariable model and to estimate optimism in the resulting regression coefficients (β) and corresponding 95% confidence intervals (CIs). Inconsistency in results of different studies that evaluated the same independent risk factors for a given outcome is common. One possible explanations for this inconsistency is discrepancy in methodologic and statistical approaches. Performing regression analysis in conjunction with bootstrap analysis can increase reproducibility and reliability of independent risk factors for an outcome (14, 15). STATA version 14 were used for statistical analysis of the data.

## Results
A total of 97 stroke patients were enrolled (age 67±79 years, 55.7% male). A detailed prevalence of quality and patterns of the seven domains of sleep are presented in

Figure 1. The prevalence (95% CI) of poor sleep (global PSQI score > 5) was 0.84 (0.75, 0.91) in stroke patients. Among the seven domains of sleep, experiencing sleep disturbance, daytime dysfunction and use of sleep medication was 1%, 15% and 28%, respectively. Prevalence of sleep efficiency of < 65% was 12%, moreover, during the past month, 14% of patients had actual sleep of < 5 hours at night. Fourteen percent of patients reported their sleep quality as very bad and moreover, 14% had very severe problem with sleep latency.

Descriptive statistics of global PSQI score across participant's background and risk factors of stroke as well as univariate analyses are shown in Table 1. After univariate screening for potential significant predictors of global PSQI score, blood lipid, nervous tension, CT scan results, treatment method, immobility, vision problem and cardiac problem had p < 0.2 and these predictors were included in multivariable analyses. The results of multivariable analyses are presented in Table 2. There is no evidence for multicollinearity among variables included in the model because VIF for all variables included was less than 1.5 (mean VIF = 1.25). The results showing significant predictors of global PSQI score were nervous tension, treatment methods, and CT scan results (p ≤ 0.05). Those with nervous tension and with surgery had a predicted increase of 1.65 and 2.91 in the mean of the global PSQI score, respectively. Compared with hemorrhagic stroke patients, those with non-hemorrhagic stroke had a predicted increase of 3.25 in their global PSQI score. The association between cardiac problems and global PSQI score was positive with β (95% CI) of 2.13 (-0.13, 4.40); p = 0.06. The estimated regression coefficients from the bootstrapped model were similar with corresponding figures from the original dataset, however, corresponding 95% CIs from bootstrapped model tend to be narrower compared with that from the original dataset.

**Table 1. Distribution of Global Pittsburgh Sleep Quality Index Score According to Participant's Background and Risk Factors of Stroke as Well as Univariate Analyses**

| Participant's background | N (%) | Mean (SD) | Univariable model β (95% CI) | P |
|---|---|---|---|---|
| sex | | | | |
| Male | 54 (55.7) | 7.58 (3.79) | References | |
| Female | 43 (44.3) | 8.44 (4.39) | 0.86 (-0.83, 2.56) | 0.31 |
| Place | | | | |
| Urban | 58 (59.8) | 7.91 (4.18) | References | |
| Rural | 39 (40.2) | 7.97 (3.89) | 0.06 (-1.65, 1.77) | 0.94 |
| Risk factors of stroke | | | | |
| Blood disorders | | | | |
| No | 90 (92.8) | 7.75 (4.03) | References | |
| Yes | 7 (7.2) | 9.57 (3.10) | 1.81 (-1.28, 4.91) | 0.24 |
| Older age | | | | |
| No | 35 (36.1) | 8 (4.64) | References | |
| Yes | 62 (63.9) | 7.82 (3.60) | -0.17 (-1.85, 1.50) | 0.83 |
| CVD | | | | |
| No | 68 (70.1) | 7.66 (4.11) | References | |
| Yes | 29 (29.9) | 8.14 (3.68) | 0.75 (-1.00, 2.50) | 0.40 |
| Genetic factors | | | | |
| No | 67 (69.1) | 7.79 (3.91) | References | |
| Yes | 30 (30.9) | 8.1 (4.20) | 0.30 (-1.43, 2.05) | 0.72 |
| Hypertension | | | | |
| No | 36 (37.1) | 7.83 (4.23) | References | |
| Yes | 61 (62.9) | 7.91 (3.86) | 0.08 (-1.58, 1.75) | 0.92 |
| Blood sugar | | | | |
| No | 63 (69.4) | 7.26 (4.03) | References | |
| Yes | 34 (30.6) | 9.02 (3.68) | 1.75 (0.10, 3.41) | 0.03 |
| Metabolic diseases | | | | |
| No | 89 (91.7) | 7.82 (4.01) | References | |
| Yes | 8 (8.3) | 8.65 (3.77) | 0.80 (-2.12, 3.73) | 0.58 |
| Smoking | | | | |
| No | 64 (66) | 8.15 (4.29) | References | |
| Yes | 33 (34) | 7.36 (3.30) | -0.79 (-2.48, 0.9) | 0.35 |
| Blood lipid | | | | |
| No | 72 (74.2) | 7.36 (4.01) | References | |

| | | | | |
|---|---|---|---|---|
| Yes | 25 (25.8) | 9.4 (3.54) | 2.03 (0.24, 3.83) | 0.03 |
| **Nervous tension** | | | | |
| No | 19 (19.6) | 6.52 (3.79) | References | |
| Yes | 78 (80.4) | 8.21 (3.98) | 1.69 (-0.31, 3.69) | 0.09 |
| **CT Scan Results** | | | | |
| Hemorrhagic | 16 (16.8) | 9.37 (3.77) | References | |
| Non-hemorrhagic | 76 (80) | 7.69 (3.95) | -1.67 (-3.86, 0.50) | 0.13 |
| No injury | 3 (3.2) | 5.66 (6.35) | -3.70 (-8.70, 1.28) | 0.14 |
| **Final diagnosis** | | | | |
| CVA ischemic | 76 (80.8) | 7.96 (4.02) | References | |
| CVA hemorrhagic | 13 (13.8) | 9.23 (3.81) | 1.27 (-1.08, 3.62) | 0.28 |
| Mild CVA | 5 (5.4) | 5 (2.82) | -2.96 (-6.58, 0.66) | 0.11 |
| **Treatment method** | | | | |
| Medical | 79 (84) | 8.30 (3.81) | References | |
| Surgical | 15 (16) | 6.26 (4.62) | -2.03 (-4.24, 0.17) | 0.07 |
| **Stroke complication** | | | | |
| **Immobility** | | | | |
| No | 51 (53.1) | 7.25 (3.56) | References | |
| Yes | 45 (46.9) | (8.64 (4.37) | 1.38 (-0.22, 2.99) | 0.09 |
| **Urinary problem** | | | | |
| No | 73 (76) | 7.71 (4.26) | References | |
| Yes | 23 (24) | 8.52 (3.01) | 0.81 (-1.09, 2.71) | 0.40 |
| **Vision problem** | | | | |
| No | 71 (73.9) | 7.57 (4.07) | References | |
| Yes | 25 (26.1) | 8.84 (3.70) | 1.26 (-0.57, 3.10) | 0.17 |
| **Hearing problem** | | | | |
| No | 83 (86.4) | 7.86 (4.08) | References | |
| Yes | 13 (13.6) | 8.15 (3.55) | 0.28 (-2.09, 2.66) | 0.81 |
| **Respiratory problem** | | | | |
| No | 57 (59.3) | 7.59 (4.13) | References | |
| Yes | 39 (40.7) | 8.35 (3.80) | 0.76 (-0.89, 2.41) | 0.36 |
| **Cardiac problem** | | | | |
| No | 80 (83.3) | 7.55 (3.86) | References | |
| Yes | 16 (16.7) | 9.68 (4.34) | 2.13 (0.006, 4.28) | 0.05 |

**Table 2. Multivariable Linear Regression Analysis as Well as Bootstrapped Model for Estimating the Effect of Participant's Background on Global Pittsburgh Sleep Quality Index Score**

| Variables | Multivariable model (original model) β (95% CI) | P | Multivariable model (bootstrapped model) β (95% CI) | P |
|---|---|---|---|---|
| **Blood sugar** | | | | |
| No | References | | References | |
| Yes | 0.20 (-1.64, 2.05) | 0.82 | 0.20 (-1.43, 1.85) | 0.80 |
| **Blood lipid** | | | | |
| No | References | | References | |
| Yes | 0.62 (-2.50, 1.26) | 0.51 | 0.62 (-2.41, 1.16) | 0.49 |
| **Nervous tension** | | | | |
| No | References | | References | |
| Yes | 1.65 (-0.33, 3.65) | 0.10 | 1.65 (0.02, 3.29) | 0.04 |
| **Result of CT scan** | | | | |
| Hemorrhagic | References | | References | |
| Non-hemorrhagic | 3.25 (0.94, 5.56) | 0.006 | 3.25 (1.14, 5.35) | 0.002 |
| No injury | 5.49 (0.53, 10.45) | 0.03 | 5.49 (-1.23, 12.22) | 0.11 |
| **Treatment method** | | | | |
| Medical | References | | References | |
| Surgical | 2.91 (0.62, 5.21) | 0.01 | 2.91 (0.60, 5.23) | 0.01 |
| **Immobility** | | | | |
| No | References | | References | |

| | | | | |
|---|---|---|---|---|
| Yes | 1.42 (-0.18, 3.03) | 0.08 | 1.42 (-0.07, 2.91) | 0.06 |
| **Vision problem** | | | | |
| No | References | | References | |
| Yes | 0.50 (-1.52, 2.52) | 0.62 | 0.50 (-1.23, 2.23) | 0.57 |
| **Cardiac problem** | | | | |
| No | References | | References | |
| Yes | 2.13 (-0.06, 4.33) | 0.06 | 2.13 (-0.13, 4.40) | 0.06 |
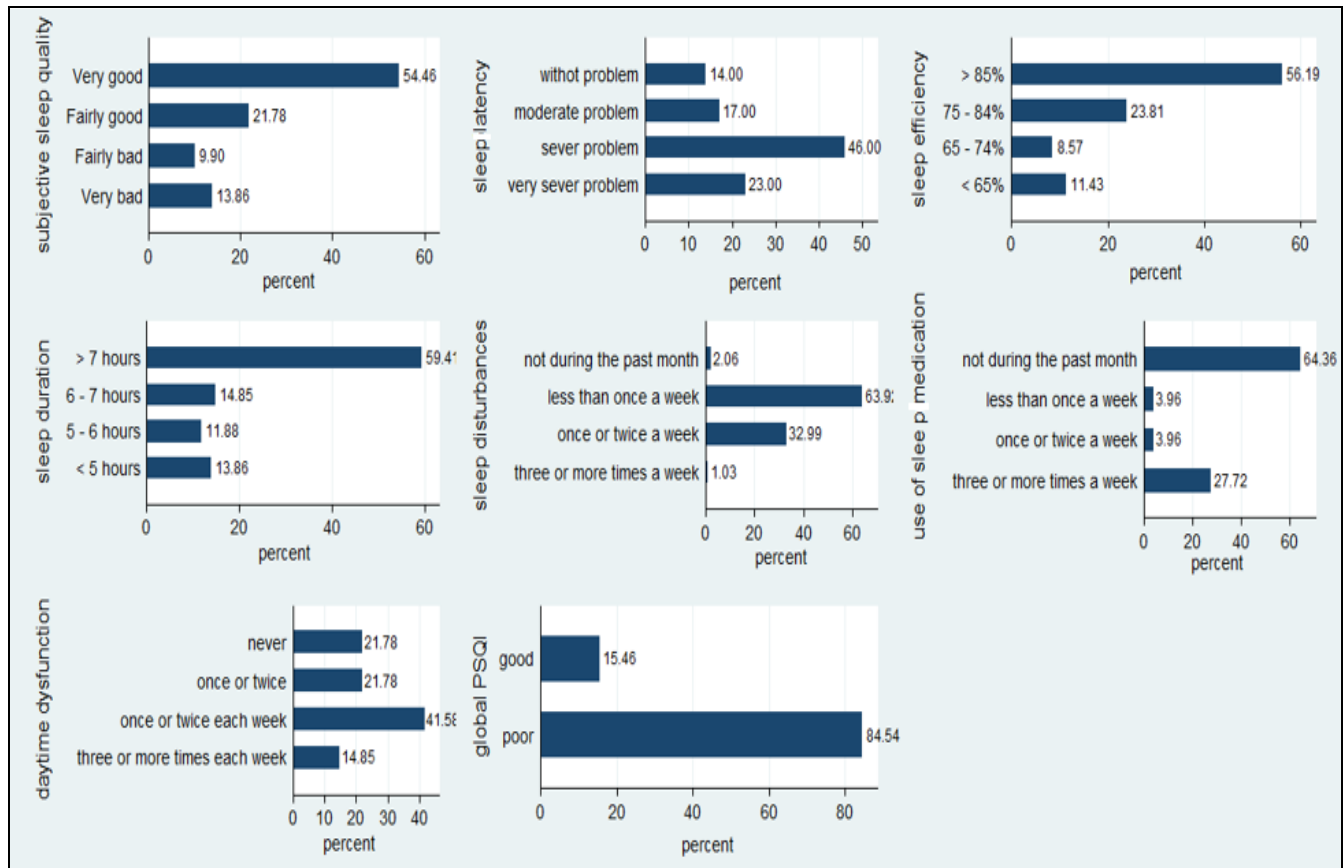


**Figure 1. Descriptive Analyses of Global Pittsburgh Sleep Quality Index as Well as Seven Sleep Domains**

## Discussion

Sleep disorder is commonly reported in patients with stroke and is associated with consequences of stroke. On the other hand, as quality of sleep directly affects people's health and poor sleep quality can worsen clinical conditions and lead to dysfunction in patients with stroke, it is important to investigate different aspects of sleep in these patients. The results of this study showed that sleep disorder is considerable in stroke patients and according to results obtained for the PSQI score, significant predictors of global PSQI score were methods of treatment, nervous tension, CT scan results and cardiac problems.

We found that prevalence of poor sleep (global PSQI score > 5) in these patients was 84%. In the study by Oliveira *et al.* in Brazil, 70.6% of patients had general sleep disorder (16). Karaca in his study in Turkey

estimated sleep disorders in stroke patients to be 39.1% (17). Results of numerous studies show that post-depression sleep disorder is common in 20-75% of stroke patients (1, 8). In another study, in hospitalized adults with acute stroke, rate of sleep disorder was 78% (1), while this rate is 30% in the general population (18). Moreover, nearly half of patients in Hofmeijer *et al.*'s study did not reach REM or deep sleep and, if reached, its duration was too short (19). Differences in sleep disturbance assessment methods, different study populations, differences in age groups of patients may justify these differences. Another reason may be that damaged brain areas following stroke handle different features of sleep quality such as the preoptic area, brainstem and the hypothalamus (20).

According to results obtained in this study, patients with hemorrhagic CT scan experience worse sleep quality.

Karaca in his study conducted on stroke patients in Turkey found that there is no significant difference in sleep quality in patients with ischemic stroke and hemorrhagic stroke (17). However, Pasic *et al.* found that cases of hemorrhagic stroke were more likely to be affected by sleep disturbance (82.5% vs. 76.8%) (1). Wells *et al.* found a significant relationship between sex and sleep quality, in which men experienced better sleep quality compared to women (21). However, we could not these results in the present study. Results of another study in Brasilia was inconsistent with our findings (22). These differences can be due to the different age range and pathology in these studies.

Our data suggest that cigarette smoking patients did not experience poorer sleep quality. Effect of smoking on sleep quality has been demonstrated previously and it is associated with greater nicotine dependence (23). Liu *et al.*, in their study regarding the effect of smoking on memory and sleep quality in healthy smokers, found that cigarette smoking can impair memory and harmfully effect sleep quality (23). We found that patients with cardiac problems and surgery for treatment had better global PSQI score. Karaca *et al.* found that depression and comorbid diseases had worse effects on sleep quality in stroke patients (17). Since no other study has yet examined the effects of these factors on sleep quality, determining causal mechanisms needs further investigation.

## Limitation

The current study had some limitations: First, the study design was cross-sectional, and therefore it is not possible to determine whether sleep disturbance occurred in patients before or after their stroke. As we know, sleep disorder is a known risk factor for stroke (15). Secondly, due to the small sample size in this study, generalizability of data should be with caution. Finally, because gathering of information was based on self-reporting, the data was prone to information bias.

## Conclusion

Nervous tension, method of treatment, CT scan results and cardiac problems were the most effective factors on post-stroke sleep disorder. Given that sleep disorders are frequent and have an impact on stroke outcome, psychiatrists and neurologists should pay close attention to quality of sleep in these patients for their treatment strategies.

## Acknowledgment

## Conflict of Interest

None.

## References

1. Pasic Z, Smajlovic D, Dostovic Z, Kojic B, Selmanovic S. Incidence and types of sleep disorders in patients with stroke. Med Arh. 2011;65(4):225-7.
2. Haacke C, Althaus A, Spottke A, Siebert U, Back T, Dodel R. Long-term outcome after stroke: evaluating health-related quality of life using utility measurements. Stroke. 2006;37(1):193-8.
3. Gokkaya NK, Aras MD, Cakci A. Health-related quality of life of Turkish stroke survivors. Int J Rehabil Res. 2005;28(3):229-35.
4. Leegaard OF. Diffuse cerebral symptoms in convalescents from cerebral infarction and myocardial infarction. Acta Neurol Scand. 1983;67(6):348-55.
5. Kim BJ, Lee S-H, Shin C-W, Ryu W-S, Kim CK, Yoon B-W. Ischemic stroke during sleep: its association with worse early functional outcome. Stroke. 2011;42(7):1901-06.
6. Carlson BW, Neelon VJ, Carlson JR, Hartman M, Dogra S. Cerebrovascular disease and patterns of cerebral oxygenation during sleep in elders. Biol Res Nurs. 2009;10(4):307-17.
7. Wallace DM, Ramos AR, Rundek T. Sleep disorders and stroke. Int J Stroke. 2012;7(3):231-42.
8. Leppävuori A, Pohjasvaara T, Vataja R, Kaste M, Erkinjuntti T. Insomnia in ischemic stroke patients. Cerebrovasc Dis. 2002;14(2):90-7.
9. Ramar K, Surani S. The relationship between sleep disorders and stroke. Postgrad Med. 2010;122(6):145-53.
10. Bassetti CL, Aldrich MS. Sleep electroencephalogram changes in acute hemispheric stroke. Sleep Med. 2001;2(3):185-94.
11. Broughton R, Baron R. Sleep patterns in the intensive care unit and on the ward after acute myocardial infarction. Electroencephalogr Clin Neurophysiol. 1978;45(3):348-60.
12. Buysse DJ, Reynolds CF, 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989;28(2):193-213.
13. Malek M, Halvani G, Fallah H. A study of the relationship between the Pittsburgh sleep quality index and road accidents among truck drivers. tkj. 2011;3(1):14-20.
14. Naftel DC. Do different investigators sometimes produce different multivariable equations from the same data? J Thorac Cardiovasc Surg. 1994;107(6):1528-9.
15. Zhang S, Chang C, Zhang J, Song B, Fang H, Xu Y. Correlation analysis of sleep quality and

youth ischemic stroke. Behav Neurol. 2014;2014:246841.

16. Oliveira GDP, Vago ERL, Prado GFD, Coelho FMS. The critical influence of nocturnal breathing complaints on the quality of sleep after stroke: the Pittsburgh Sleep Quality Index and STOP-BANG. Arq Neuropsiquiatr. 2017;75(11):785-8.

17. Karaca B. Factors Affecting Poststroke Sleep Disorders. J Stroke Cerebrovasc Dis. 2016;25(3):727-32.

18. Hofmeijer J, van Kaam R, Vermeer SE, van Putten M. Severely Disturbed Sleep in Patients With Acute Ischemic Stroke on Stroke Units: A Pilot Study. Front Neurol. 2019;10:1109.

19. Ferre A, Ribó M, Rodríguez-Luna D, Romero O, Sampol G, Molina CA, et al. Strokes and their relationship with sleep and sleep disorders. Neurologia. 2013;28(2):103-18.

20. Wells RD, Day RC, Carney RM, Freedland KE, Duntley SP. Depression predicts self-reported sleep quality in patients with obstructive sleep apnea. Psychosom Med. 2004;66(5):692-7.

21. Da Rocha PC, Barroso MT, Dantas AA, Melo LP, Campos TF. Predictive factors of subjective sleep quality and insomnia complaint in patients with stroke: implications for clinical practice. An Acad Bras Cienc. 2013;85(3):1197-206.

22. Purani H, Friedrichsen S, Allen AM. Sleep quality in cigarette smokers: Associations with smoking-related outcomes and exercise. Addict Behav. 2019;90:71-6.

23. Liu JT, Lee IH, Wang CH, Chen KC, Lee CI, Yang YK. Cigarette smoking might impair memory and sleep quality. J Formos Med Assoc. 2013;112(5):287-90.