Poor Sleep Quality I Related to Impaired Functional Status Following Stroke

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Introduction: Sleep disorders are more prevalent in patients with previous stroke compared to healthy individuals. The main objective of the present study was to investigate the impact of sleep quality on the functional status of patients with a history of stroke, upon admission to inpatient rehabilitation. *Methods:* Fifty patients (mean age: 69 ± 11 years) with previous stroke were consecutively included in this single center cross-sectional observational study upon admission to inpatient rehabilitation. Pittsburgh Sleep Questionnaire Index (PSQI) was calculated for all patients and patients were divided into 2 groups according to PSQI scores (PSQI ≤ 5 as good sleepers and PSQI > 5 as poor sleepers). A specialist evaluated the level of muscle spasticity and disability, walking capability, and overall performance of daily activity of all enrolled patients using the functional ambulation scale (FAS) score, modified Brunnstrom Classification, Modified Ashworth scale, and Beck Depression Inventory. *Results:* The FAS score (3.4 ± 1.3 versus 1.8 ± 1.7, $P = .004$) and Brunnstrom scores of upper limb (3.8 ± 1.1 versus 2.5 ± 1.6, $P = .005$), lower limb (4.3 ± 1.4 versus 3.1 ± 1.7, $P = .013$) and hand (3.6 ± 1.5 versus 2.3 ± 1.6, $P = .006$) were significantly higher in good sleepers than poor sleepers. Linear regression analysis revealed that PSQI score (coefficient $\beta = -.360$, 95% CI: −.212-.032, $P = .009$) and age (coefficient $\beta = -.291$, 95% CI: .100-.245, $P = .032$) were independently associated with FAS score. *Conclusion:* Results of the present study indicate that presence of poor sleep quality is associated with poor functional status which might further impair the outcomes of the rehabilitation and accordingly the health-related quality of life in patients admitted for stroke rehabilitation.

Key Words: Sleep—hemiplegia—rehabilitation— functional status

Introduction

Stroke represents the leading cause of long term functional impairment with extreme physical and psychological consequences among survivors and their families, and is among the top 3 causes of death and premature disability worldwide. Studies have shown that over a quarter of stroke patients are below the age of 65.[1] The incidence of stroke is decreasing in developed countries; whereas an increase in stroke incidence has been recorded in low-income and middle-income countries during the last 2 decades. Owing to the increase in stroke incidence, it is expected that by 2030, there will be almost 12 million deaths due to stroke, 70 million stroke survivors, and more than 200 million disability-adjusted life-years will be lost globally.[2] Given the increasing amount of strokes globally and the large number of individuals left with disabilities after stroke, eliminating factors that negatively influence the functional status of patients with stroke is of major importance. Therefore, rehabilitation programs for stroke patients mainly aim to improve functional independence needed for performance of daily activities and to integrate them into community life.

Sleep disorders are more prevalent in patients with a history of stroke compared to those without. Various kinds of sleep disturbances such as sleep apnea, insomnia and daytime sleepiness, which may impact the individuals' participation in rehabilitation programs have been documented in stroke patients.[3,4] However, the role of sleep quality on the functional status of patients with a

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history of stroke has not been investigated yet. In the present study, we investigated the impact of sleep quality on the functional status of patients with previous stroke upon admission to inpatient rehabilitation.

Material and Methods

Patient Selection

Fifty patients aged between 20 and 85 years (mean ± SD: 69 ± 11) with previous stroke admitted to the neurorehabilitation unit of Famagusta State Hospital from January 2016 to February 2017 were consecutively included in this single center cross-sectional observational study upon admission to inpatient rehabilitation. Patients with uncontrolled diabetes and hypertension, previous cardiovascular disease, previous neurological disease other than stroke, malignancies, and those with pre-existing sleep disorders before the stroke event, were not included in the study. All subjects underwent a detailed systemic physical examination including neurologic and musculoskeletal evaluations. Data concerning demographic features of the study population were recorded for each patient. The Pittsburgh Sleep Questionnaire Index (PSQI) was calculated for all patients, and they were divided into 2 groups according to PSQI scores. We defined patients with a PSQI higher than 5 points as poor sleepers, while those with PSQI scores lower or equal to 5 were defined as good sleepers. Today, it is widely accepted that a PSQI score greater than 5 indicates poor sleeping quality and a PSQI score less than 5 indicates a good sleeping quality.[5] This study was approved by the Institutional Ethical Committee and the study was performed in accordance with the most recent version of the Helsinki Declaration.

Evaluation of Sleep Quality

As mentioned before, we used the PSQI scale to evaluate sleep. The PSQI is a reliable, valid, and standardized measure of sleep quality.[6] It consists of 7 components scored from 1 to 3 including the following: (1) subjective sleep quality (very good to very bad), (2) sleep latency (≤15 minutes to > 60 minutes), (3) sleep duration (≥7 hours to <5 hours), (4) sleep efficiency (≥85% to <65% hours sleep/hours in bed), (5) sleep disturbances (no disturbances during the past month to ≥3 times per week), (6) use of sleeping medications (none to ≥3 times a week), and (7) daytime dysfunction ("not a problem" to "a very big problem"). Scores for all components are added to obtain a final overall score ranging between 0 and 21. All evaluations were performed by the same attending physician.

Functional Assessment

At enrollment, a professionally trained specialist evaluated the level of muscle spasticity and disability, walking capability, and overall performance of daily activity in each patient. To determine the functional capacity of patients in terms of gait, we used the Holden functional ambulation scale (FAS) score ranking from 1 to 5, with higher scores indicating better walking capability.[7] The Modified Brunnstrom Classification (MBC) was used separately for functional classification of the affected upper limb, lower limb, and hand, scored from 1 to 6, with higher scores indicating better function.[8] The Modified Ashworth scale was used to evaluate the severity of spasticity in the flexor muscles of upper limb and lower limb. Patients were categorized from 1 to 5, with higher scores indicating increased muscle tone.[9] The Beck Depression Inventory (BDI) was used to determine the depressive symptoms of the participants.

Statistical Analyses

Statistical analysis was performed using SPSS for Windows, version 17 (SPSS, Chicago, IL). The Kolmogorov-Smirnov test was used to determine whether or not the variables were distributed normally. Continuous variables are presented as mean ± standard deviation and categorical variables as frequency (n) and percentage (%). Comparisons among groups with respect to demographic data, PSQI scores and functional assessment scores were performed using the student's t test. The chi-square test was used for univariate analysis of the categorical variables. Linear regression analysis was performed to identify significant relationships between the PSQI scores and functional evaluation scores of the patients. Correlation analysis was performed to investigate the association between PSQI score and selected variables of functional status. Two sided P values lower or equal to .05 were interpreted as statistically significant.

Results

The fifty patients included in the study were grouped according to PSQI scores (≤5 good sleepers, and >5 poor sleepers). The poor sleepers group consisted of 32 patients (mean age 71 ± 9 years, 56% male) and the good sleepers group consisted of 18 patients (mean age: 68 ± 9 years, 55% male). The demographic variables of the 2 groups, including age, gender, etiology of stroke, affected side, duration with hemiplegia, presence of family support, and antidepressant drug use, are shown in Table 1. In addition, the PSQI scores, Brunnstrom scores, MAS scores, and Beck depression scores of the groups are also presented in Table 1. The PSQI scores of good sleepers were significantly lower than poor sleepers (3.6 ± 2.2 versus 13.5 ± 3.1, $P = .001$). The FAS score (3.4 ± 1.3 versus 1.8 ± 1.7, $P = .004$) representing walking function and Brunnstrom scores of upper limb (3.8 ± 1.1 versus 2.5 ± 1.6, $P = .005$), lower limb (4.3 ± 1.4 versus 3.1 ± 1.7, $P = .013$) and hand (3.6 ± 1.5 versus 2.3 ± 1.6, $P = .006$) were significantly higher in good sleepers than poor sleepers (Fig. 1). BDI scores were also significantly higher

Table 1. *Patient characteristics of poor sleepers and good sleepers*

	Poor sleepers n = 32	Good sleepers n = 18	*P* value
Age, (years)	71 ± 9	68 ± 9	.376
Male n (%)	18 (56%)	10/8 (55%)	.962
Ischemic stroke, n (%)	28 (87%)	13 (72%)	.177
Right sided hemiplegia, n (%)	13 (40%)	6 (33%)	.610
Family support, n (%)	22 (68%)	15 (83%)	.259
Hemiplegia duration, (years)	6.3 ± 7.6	9.2 ± 7.4	.196
Antidepressant use, n (%)	20 (62%)	7 (39%)	.108
PSQI score	13.5 ± 3.1	3.6 ± 2.2	.001
FAS score	1.8 ± 1.7	3.4 ± 1.3	.004
Brunnstrom (UL)	2.5 ± 1.6	3.8 ± 1.1	.005
Brunnstrom (LL)	3.1 ± 1.7	4.3 ± 1.4	.013
Brunnstrom (Hand)	2.3 ± 1.6	3.6 ± 1.5	.006
Ashworth (UL)	1.7 ± 0.6	1.5 ± 0.8	.241
Ashworth (LL)	1.3 ± 0.6	1.1 ± 0.3	.136
Beck depression index	18.2 ± 7.2	11.2 ± 6.8	.001

Abbreviations: FAS, functional ambulation scale; LL, lower limb; PSQI, Pittsburgh Sleep Questionnaire Index; UL, upper limb.

in patients with poor sleep quality compared to those with good sleep quality (18.2 ± 7.2 versus 11.2 ± 6.8, $P = .001$).

Linear regression analysis revealed that PSQI score (coefficient $\beta = -.360$, 95% CI: −.212-.032, $P = .009$) and age (coefficient $\beta = -.291$, 95% CI: .100-.245, $P = .032$) were significantly associated with FAS score (Table 2). Table 3 shows the correlations between PSQI score and Brunnstrom scores of upper limb (r = −.429, $P = .002$), PSQI score and Brunnstrom scores of lower limb (r = −.396, $P = .004$) and PSQI score and Brunnstrom scores of the affected hand (r = −.444, $P = .001$). In addition, PSQI score was also significantly correlated with BDI scores (r = .463, $P < .001$).

Discussion

The present study reveals that, at the time of admission to the neurorehabilitation unit, patients with previous stroke and poor sleep quality had impaired functional status compared to those with good sleep quality, as measured by FAS and MBC. This study also demonstrates that PSQI score, a surrogate marker of sleep quality, is independently associated with FAS and MBC scores indicating a strong relationship between poor sleep quality and poor functional status. Additionally, our findings show that there is a strong correlation between the PSQI score and BDI scores in patients with previous stroke, indicating an impaired psychological status among these patients.

To our knowledge, the literature is limited regarding the presence of sleep disorders in patients with a history of stroke. In questionnaire based studies, sleep quality was reported to be impaired and daytime sleepiness was found to be frequent (ranging between 34% to 67%) among those who had suffered a stroke.[10,11] A substantial number of these patients also report weakened daytime functioning caused by daytime sleepiness and the resultant fatigue.[12] Electroencephalography based studies conducted in patients with chronic motor stroke demonstrate slower frequencies in resting state during daytime which might be interpreted as a marker of sleep deprivation.

Sleep disorders are known to adversely affect social relations, to increase anxiety among family members and healthcare workers, and to negatively influence the participation of the patient in rehabilitation programs by altering cognitive and physical functionality even in the healthy elderly population.[13] Several kinds of sleep disorders, including insomnia, hypersomnia with excessive daytime sleepiness, narcolepsy, parasomnia, and movement disorders, developing mainly due to alterations in sleep architecture, have been documented in acute and chronic stroke patients.[14] In a study conducted in Korean hospitals, investigators found that presence of insomnia was negatively correlated with physical and mental health-related quality of life even in at the early stages of rehabilitation.[15] Presence of these disorders in patients with previous stroke might interfere with functional recovery by decreasing the patient's energy, motivation and quality of rest.

The main object of poststroke rehabilitation is to minimize disabilities, maintain physical independence and increase health related quality of life. In patients with previous stroke, several factors have been proposed to have an impact on outcomes following rehabilitation. A study performed by Lin et al revealed that Functional Independence Measure, Severity of stroke (determined via the Canadian Neurological Scale) and age were independent predictors of functional outcomes at discharge from hospital in recipients of stroke rehabilitation.[16] In another study, various factors likely to predict motor and functional outcomes after stroke were investigated and the authors reported that factors such as social interaction,

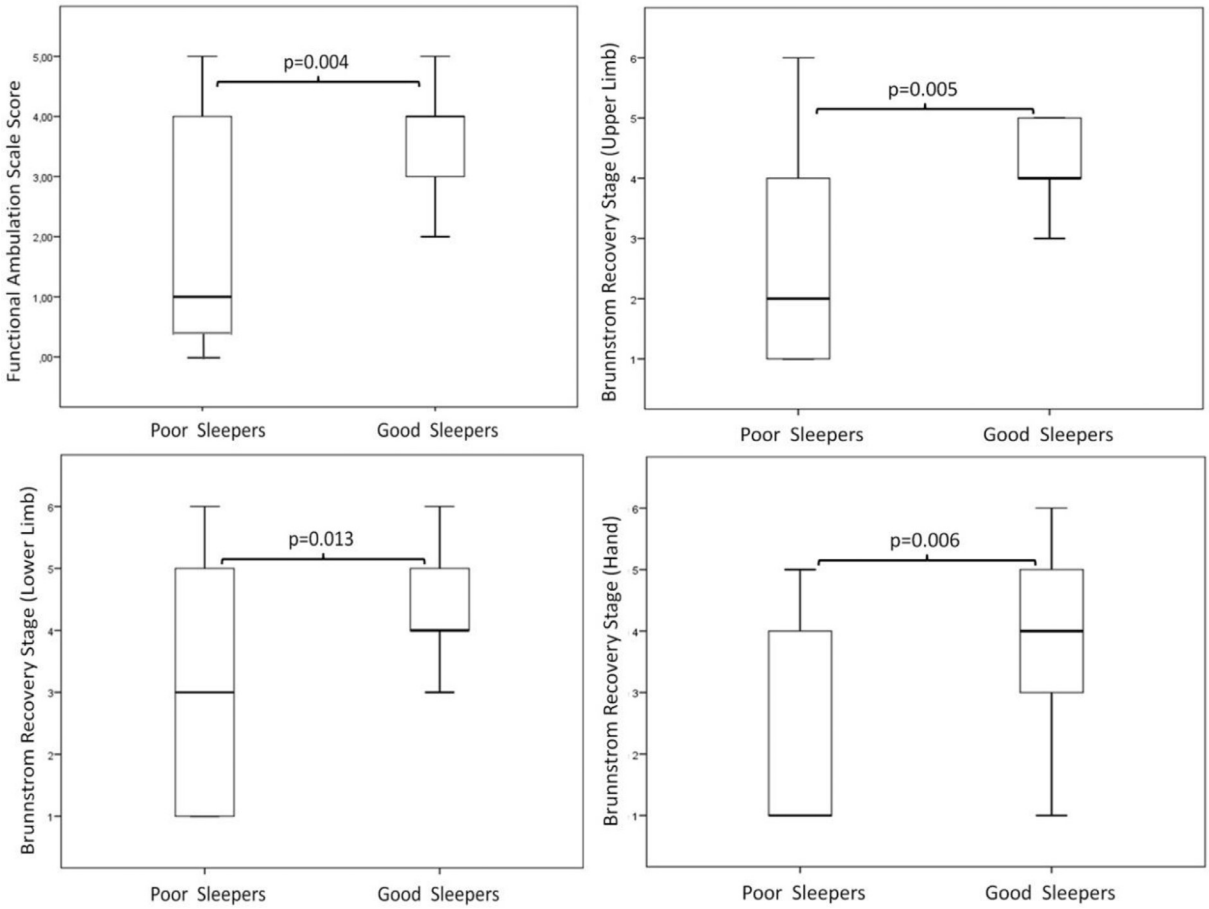

Figure 1. *Functional ambulation scale scores and Brunnstrom scores of patients with poor and good sleep quality.*

grooming, upper body dressing, and bowel control were the most important stroke outcome predictors during inpatient rehabilitation.[17] In addition, smoking and presence of hypertension and diabetes were also predictors of poor outcome in patients undergoing rehabilitation for previous stroke.[18]

Although its influence on deterioration of health-related quality of life in patients with stroke is well-known, data regarding the influence of sleep disorders on functional status and recovery of patients with stroke is lacking. One of the preliminary trials studying the association between sleep disorders and outcomes of rehabilitation following stroke was carried out by Cherkassky et al.[19] In that study, the authors reported that the presence of hypoxic events during sleep was an independent predictor for a poorer recovery, especially in stroke patients with poor function at admission. More recently, Joa et al investigated the role of sleep disorders and insomnia on the functional outcomes of stroke and found that sleep disorders have negative effects on functional recovery, particularly on balance improvement.[20] In another study investigating the relationships between sleep disorders and functional outcome following stroke, Moon et al

Table 2. *The relationship of FAS score with selected variables in linear regression analysis*

	Coefficients-β	95% CI	*P*
Age	−.291	−.086-.004	.032
Gender		−1.232-.810	.679
Hemiplegia duration	.054	−.053-.079	.693
Family support	.205	−.271-1.976	.133
Hemiplegia side	.131	−.443-1.430	.294
PSQI score	−.360	−.212-.032	.009

Abbreviations: FAS, functional ambulation scale; PSQI, Pittsburgh Sleep Questionnaire Index.

Table 3. *Correlations between total PSQI score and selected measures of functional status*

	r	*P*
FAS score	−.484	<.001
Brunnstrom (UL)	−.429	.002
Brunnstrom (LL)	−.396	.004
Brunnstrom (Hand)	−.444	.001
Beck depression index	.463	<.001

Abbreviations: FAS, functional ambulation scale; LL, lower limb; PSQI, Pittsburgh Sleep Questionnaire Index; UL, upper limb.

demonstrated that presence of sleep disorders was an independent predictor of balance and gait function after a 1-month rehabilitation program.[21] Obstructive sleep apnea is one of the most studied sleep disorders in patients with stroke. In a study performed by Aaronson et al, it was reported that pre-existing obstructive sleep apnea was significantly associated with impaired cognitive and functional status in patients admitted for stroke rehabilitation.[22] Recently, Akdeniz et al investigated the sleep quality of patients with previous stroke and compared their findings with healthy controls. In that study, authors found that sleep quality, as measured by the PSQI, was significantly impaired in patients with stroke. Moreover, they found a significant negative correlation between PSQI scores and Brunnstrom recovery stage and FAS scores.[23]

In the present study, we found that a relatively high proportion of the study population suffered from sleep disorders which is consistent with previous findings. Additionally, we also demonstrated that the functional status of patients was significantly impaired in poor sleepers compared to good sleepers. To the best of our knowledge, this is the first study that compared the functional status of patients with and without sleep disorders using a detailed neuropsychological assessment. In contrast to previous studies, here we used PSQI to determine sleep quality instead of evaluating the presence/absence of specific diseases that are potentially deteriorative for sleep quality. We also showed a negative correlation between sleep quality and functional status of patients which is consistent with the previous data reported by Akdeniz et al. Considering the fact that poststroke functional status is one of the main predictors of functional outcome after rehabilitation, we believe that impaired sleep quality may adversely affect the success of rehabilitation programs by worsening prerehabilitation functional status. In the light of our findings, we believe that early diagnosis and treatment of sleep disorders in patients who have suffered from stroke may improve rehabilitation outcome.

Limitations

Our study has some limitations to be mentioned. This study is a single center, observational study without a control group and a predetermined follow-up period; therefore, our results are correlational and do not imply causality. However, the strong relationship between sleep quality and functional status shown in our study may indicate that poor sleep quality is a reason for poor functional status. Another weak point of our study is the enrollment of patients after a relatively long duration after the stroke event. Despite this, our study provides reliable data to demonstrate the real life experience of these patients, as only a small proportion of patients in developing countries participate in neurorehabilitation soon after the stroke.

To determine sleep quality, we only used the PSQI which is a simple but time consuming questionnaire instead of more sophisticated quantitative measurements. Nevertheless, current literature indicates that determining the sleep quality with PSQI is a simple way of identifying poor and good sleepers in the clinical setting. In addition, we assessed the functional status of patients only at admission. Repeated measurements following rehabilitation and regular evaluations of sleep quality would provide more data regarding the role of sleep disorders on functional outcomes after rehabilitation. Lastly, there are some related items in different questionnaires. Total scores were may affected by these relationships. However, we performed correlation analyses to show these relations and we performed regression models to reveal actual associations.

Conclusion

In summary, the results of the present study indicate that presence of poor sleep quality is associated with poor functional status which might further impair the outcomes of rehabilitation and accordingly the health related quality of life in patients admitted for stroke rehabilitation. With this background in mind, we suggest the use of a simple, valid, and costless questionnaire in order to determine the severity of sleep disorders among patients. Thus, clinicians may identify sleep quality and can implement treatment options which might improve rehabilitation success and the functional status of patients with chronic stroke.

Declaration of Competing Interest

Authors declare that they have no conflict of interest.

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