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Risk of Depression Among Stroke Patients with Obstructive Sleep Apnea: A Prospective Cohort Study

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ABSTRACT

Background: Stroke survivors frequently worry about sleep disturbance, but it is still unclear how long people sleep for and if obstructive sleep apnea is linked to depression after stroke and mortality from all causes and cardiovascular disease. Our goal was to investigate these connections. **Study Design:** prospective cohort study. **Settings:** Department of Neurology, Shifa International Hospital, Islamabad. **Study duration:** February 2025 to April 2025. **Methods:** Included were adults who had survived stroke. Self-reports on pertinent questionnaires were used to obtain data on sleep and stroke diagnoses. Data on mortality were gathered. To investigate these relationships and determine the odds ratio (OR) and hazard ratio (HR), respectively, multivariate logistic regression and Cox proportional hazards regression were employed. **Results:** There were 173 stroke participants in all. Obstructive sleep apnea was linked to higher risks of depression after stroke in the fully adjusted model (OR 2.689, p = 0.0146). The likelihood of depression after stroke was inversely correlated with sleep duration; short sleep duration was linked to higher odds of depression after stroke (OR 2.196, p = 0.0059) than long sleep duration (p = 0.1445). **Conclusions:** Short sleep duration and obstructive sleep apnea were linked to higher chances of depression after stroke. These results highlight how correcting sleep disturbances and attaining a normal sleep duration may lower the risk of depression after stroke and death.

INTRODUCTION

Acute cerebrovascular disease, or stroke, is primarily divided into two types: ischemic stroke and hemorrhagic stroke. It is caused by several factors that impede blood flow to the brain, resulting in a focal neurological deficit.[1] The leading cause of mortality and disability worldwide is stroke. An estimated 12.2 million strokes occurred globally in 2019, resulting in 6.55 million fatalities and 143 million disability-adjusted life years.[2] Stroke is the second most common cause of death worldwide; in certain high-income countries, one-fifth of the population may experience a stroke at some point in their lives, whereas in low-income countries, approximately half of the population may experience a stroke.[3] Furthermore, a number of comorbidities, including depression after stroke, are closely linked to stroke. With reported prevalence rates of 27%, depression after stroke is a well-known and prevalent psychiatric illness among stroke survivors.[4,5] Depression after stroke is linked to greater mortality, worse recovery, more severe cognitive abnormalities, and a lower quality of life than stroke survivors who do not experience depression.[6,7] Stroke has a significant financial impact on people, families, and society as a whole. Each stroke sufferer in the US contributes over $60,000 annually to overall medical costs.[8] The main focus of initiatives to lower the disease burden of stroke is stroke prevention.[9] It is crucial for public health to identify and manage modifiable risk factors for depression after stroke.

Stroke and sleep are tightly linked, and many stroke survivors worry about sleep-related issues.[10] Nevertheless, there is currently a lack of research on the relationship between sleep length and post-stroke sadness. In addition, stroke survivors frequently experience sleep issues such insomnia, restless legs, and sleep apnea. There is growing evidence that sleep disturbances are linked to a higher risk of stroke.[11] Nevertheless, little research has been done on the relationship between sleep disturbances and depression and stroke mortality. While the relationship between sleep apnea and stroke survivors' mortality is still unclear[12,13], there is some weak evidence that it may be linked to a higher risk of depression following a stroke.[14]

In this work, we investigated these connections in order to fill up these research gaps. We sought to determine how sleep duration and obstructive sleep apnea were related to depression, among stroke survivors. Furthermore, we aimed to determine if non-linear

connections persist in populations with varying clinical characteristics and to explore the possibility of such associations.

MATERIALS AND METHODS

The Department of Neurology, Shifa International Hospital, Islamabad, conducted this prospective cohort study between February 2025 to April 2025. After being approved by the institutional ethical review committee, 370 patients who satisfied the inclusion criteria were selected via non-probability sequential sampling. The informed consent of each patient will be sought. With a 95% confidence level, a 3% margin of error, and an assumed frequency depression of 7.8% in stroke patients, a sample size of 370 cases has been determined. All patients, regardless of gender, who had experienced a stroke within the previous three months and were between the ages of 40 and 80 were enrolled. A stroke occurs when the arteries leading to the brain narrow or become blocked, resulting in significantly reduced blood flow, The non-contrast CT brain shows normal brain tissue, a high attenuating (bright) clot, low attenuating (black) cerebrospinal fluid (CSF), loss of the gray-white interface, and hypo-density of the basal ganglia and insular cortex. Patients with a history of mood disorders, psychotic disorders, anxiety disorders before the onset of end-stage renal illness, a history of hypothyroidism, or a history of drug and substance addiction were not included.

The Sleep Disorders Questionnaire, the length of sleep was ascertained by self-report. What is your typical nightly sleep duration on workdays or weekdays? was the query that was asked of the attendees. Sleep duration was divided into three categories: normal sleep duration (7–8 hours), short sleep duration (<7 hours), and long sleep duration (>8 hours). Obstructive sleep apnea was considered when presence of apnea when present with either or both of the following conditions: namely a) snoring; b) mouth breathing. **Obstructive Sleep Apnea Score (OSA Score):** It is a simple, non-invasive proxy measure of diagnosis and severity of obstructive sleep apnea proposed by Friedman M, et al. It provides a prediction that an individual is likely to suffer from obstructive sleep apnea (OSA). The OSA Score can help identify patients that may have OSA via physical exam alone and does not rely on history.

Calculation of composite OSA Score requires measurements for Friedman Tongue Position (FTP), Tonsil Size and Body-mass Index (BMI).

OSA Score = FTP (I-IV) + Tonsil Size (1-4) + BMI (0-4)

The expected maximum OSA Score is 12. The OSA Score ≥8 will indicate presence of OSA and OSA Score ≤4 will indicate absence of OSA7. Success of surgery and relief of OSA in a subject will be indicated by a postoperative OSA Score of ≤4. The commonly used PHQ-9 was used to measure depressive symptoms; a score of ≥10 indicates severe depression.

We performed a baseline examination of stroke patients based on their level of depression. Weighted chi-square analysis was used to analyze categorical data, which were represented as numbers (percentages), and the weighted t test was used to analyze continuous variables, which were given as mean ± standard error. The associations between the prevalence of depression in stroke survivors and sleep duration and disruptions were examined using multivariate logistic regression analyses, which yielded odds ratios (ORs) and 95% CIs. These multivariate Cox proportional hazards regression models calculated the hazard ratios (HRs) and 95% CIs and examined the associations between sleep duration and sleep disorders and long-term mortality in stroke survivors.

RESULTS

The study's age range was 40–80 years old, with a mean age of 57.95 ± 9.20 years. Of the 218 patients, the majority (58.92%) were in the 40–60 age range. 304 (82.16%) of the 370 patients were female, and 66 (17.84%) were male, giving a male to female ratio of 1:4.6. Our study's mean illness duration was 5.85 ± 2.36 months. Mean BMI was 27.36 ± 2.94 kg/m^2. Distribution of patients with other confounding variables is shown in Table I.

In our study, incidence of depression in stroke patients was found in 28 (7.57%) patients (Figure I). Stratification was used to account for effect modifiers such as age, gender, smoking, place of residence, BMI, diabetes mellitus, hypertension, and length of disease is shown in Table II.

There was still a significant correlation between obstructive sleep apnea and higher risks of depression after stroke (p = 0.0146). In a similar vein, the prevalence of depression after stroke was still inversely correlated with sleep duration (p = 0.0219). Higher rates of depression following stroke were associated with short sleep duration (p = 0.0059) but not with long sleep duration (p = 0.1445) as compared to normal sleep length.

By employing RCS analysis, a nonlinear link between sleep duration and post-stroke depression was found (p for nonlinearity <0.0001, inflection point of 8.0h). Only when sleep duration was less than eight hours (p < 0.0001) did threshold effect analysis reveal an inverse relationship between sleep duration and post-stroke depression.

Age, gender, and race/ethnicity did not significantly alter the relationship between sleep duration and sleep disorders and post-stroke depression, according to interaction analyses. Similarly, in stroke survivors, the relationship between sleep duration and mortality was unaffected by age, sex, or ethnicity. However, the link between sleep disturbances and CVD mortality was found to be effect-modified by age (p for interaction <0.001). Only people under 60 had a correlation between sleep disturbances and CVD mortality following a stroke (HR 1.244, p = 0.002).

Table I

Distribution of patients with other confounding variables (n=370)

Confounding variables		Frequency	%age
Age (years)	40-60	218	58.92
	61-80	152	41.08
Gender	Male	66	17.84
	Female	304	82.16
Duration of disease (months)	≤6	255	68.92
	>6	115	31.08
BMI (kg/m^2)	≤25	103	27.84

	>25	267	72.16
DM	Yes	92	24.84
	No	278	75.16
HTN	Yes	82	22.16
	No	288	77.84
Smoking	Yes	49	13.24
	No	321	86.76
Place of residence	Rural	132	35.68
	Urban	238	64.32

Figure I

Frequency of depression in stroke patients (n=370).

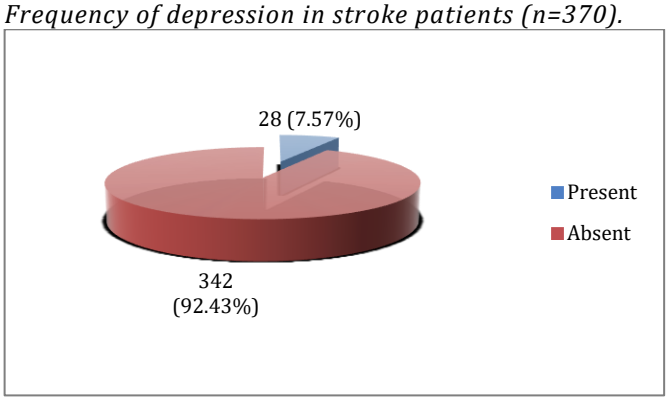

Table IV

Stratification of depression with respect to age, gender, smoking, place of residence, BMI, diabetes mellitus, hypertension, and length of disease.

		Present (n=28)	Absent (n=342)	P-value
Age (years)	40-60	18	200	0.548
	61-80	10	142	
Gender	Male	09	57	0.039
	Female	19	285	
Duration of disease (months)	≤6	23	232	0.116
	>6	05	110	
BMI (kg/m²)	≤25	09	94	0.597
	>25	19	248	
DM	Yes	08	84	0.636
	No	20	258	
HTN	Yes	19	63	0.0001
	No	09	279	
Smoking	Yes	02	47	0.322
	No	26	295	
Residence	Rural	11	121	0.678
	Urban	17	221	

DISCUSSION

As far as we are aware, this is the first thorough investigation on the relationship between depression and obstructive sleep apnea and sleep length. There is still limited research on the relationship between sleep length and depression following a stroke. According to a retrospective study of 1369 stroke survivors from the Brain Attack Surveillance in Corpus Christi project, only <6 hours of pre-stroke sleep duration was linked to a higher risk of depression 90 days after the stroke, as opposed to both 6 and >8 hours.[15]

In contrast to >7 hours of sleep length, 5–6 and <5 hours of sleep duration were linked to higher odds of depression following stroke (OR 1.47 and 3.05, respectively), according to another cross-sectional investigation from China.[16] For the first time, our research showed a negative correlation between sleep duration and a lower incidence of depression after stroke. Consistent with earlier research, short sleep duration (less than 7 hours) but not long sleep length was linked to significantly higher odds of post-stroke depression as compared to normal sleep duration. Our findings supported earlier research by demonstrating that while extended sleep duration was not linked to an increased risk of depression following a stroke, short sleep duration did. Nonetheless, our study differed from other research in a few ways. First, unlike Liu et al.'s study, included stroke patients, our investigation focused on stroke survivors who were not institutionalized.[16] Second, our study and Dong et al.[15] utilized 7–8 hours of sleep time as a reference, while the study by Liu et al. used >7 hours. Last but not least, the brief sleep duration that was particularly linked to post-stroke depression was different from other research. Furthermore, we discovered a nonlinear correlation between the likelihood of depression following a stroke and the amount of sleep. Only those who slept for less than eight hours showed this inverse connection, which then vanished. According to this research, stroke survivors should get education and positive acknowledgement of the significance of getting 8 hours of sleep each night in order to minimize post-stroke depression.

There is still little research on the connection between post-stroke sadness and obstructive sleep apnea. A retrospective analysis of 265 in-hospital ischemic stroke patients found that having severe obstructive sleep apnea (OSA) after three months was associated with a higher risk of post-stroke depression than not having OSA ($p = 0.036$).[14] 66 outpatient stroke survivors participated in a cross-sectional study that demonstrated insomnia to be an independent predictor of depression after stroke ($p < 0.001$).[17] Additionally, in a different cohort research with 608 elderly Chinese ischemic stroke patients, insomnia was associated with increased chances of depression after stroke ($p<0.01$).[18] For the first time, our results revealed that, regardless of sleep duration, a history of sleep disturbances in general was substantially linked to a higher risk of depression following a stroke.

Our research showed that stroke survivors had a 7.5% increased risk of all-cause mortality for every hour of increased sleep duration, which contradicts Wang et al.'s findings.[19] Comparing the two sleep durations to normal sleep duration, however, none was substantially linked to all-cause mortality among stroke survivors. Our study included a bigger stroke sample size and a more thorough survey cycle, which may better reflect the connections and explain these contradictory results. In particular, we hypothesized that there were multiple reasons for these contradictory results from Sawadogo et al.'s study.[20] With a bigger sample size and more thorough representation, we included more people from consecutive cycles than Wang et al.'s study.[19]

Our research may be useful in clinical settings. In summary, stroke survivors who suffer from sleep disorders are more likely to experience depression and a higher risk of dying from cardiovascular disease. For this reason, it is important for clinicians and caregivers to focus on and treat sleep disorders in stroke survivors in order to improve their prognosis and quality of life. The substantial influence of sleep problems on the risk of cardiovascular death in stroke survivors under 60 years of age requires special attention. Furthermore, stroke survivors who don't

get enough sleep should be worried about their increased risk of developing post-stroke depression. Our results indicated that the best preventive value for depression after stroke was 8 hours of sleep every night. After a stroke, evaluating and enhancing sleep quality may help detect depression early and lower the risk of cardiovascular death.

Strengths and Limitations

Our research has a number of noteworthy advantages. First, because it is a large-sample, multiracial, population-based, nationwide study, the results can be broadly applied. We minimized research bias and appropriately corrected for potential confounders. However, there may be certain restrictions on our study. Cross-sectional analyses were used to examine the relationships between depression after stroke and sleep duration and obstructive sleep apnea. We were unable to evaluate the influence of stroke severity on findings since stroke was evaluated based on participant self-report. In stroke survivors, depression and prognosis may be significantly impacted by stroke severity.[21,22] As a result, these significant clinical traits could function as confounders and affect these correlations. Notably, earlier research in this area has also not taken these confounders into account.[19,20]

CONCLUSION

Short sleep duration and obstructive sleep apnea were linked to higher probabilities of post-stroke depression in a nationwide population-based investigation. According to these results, the risk of depression may be decreased by preserving a regular sleep schedule and treating obstructive sleep apnea. To confirm these results, large sample prospective cohort studies are required in the future.

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