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A CROSS-SECTIONAL STUDY ON MENOPAUSAL SYMPTOMS, SLEEP QUALITY, AND COGNITIVE FUNCTION IN WOMEN

Shagufta Parveen, Amit Kumar*, Ayush Mishra, Lokesh Kumar Mishra, Nirmal Kumar Yadav, Abhishek Anand

Department of Pharmacy Practice, Teerthanker Mahaveer College of Pharmacy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India.

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***Corresponding Author: Amit Kumar**
Department of Pharmacy Practice, Teerthanker Mahaveer College of Pharmacy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India.
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ABSTRACT

Objective: This cross-sectional study investigated the relationships between menopausal symptoms, sleep quality, and cognitive function in women during the menopausal transition, examining whether sleep quality mediates the association between menopausal symptoms and cognitive performance. **Methods:** A sample of 586 women aged 40–60 years, stratified by menopausal stage (perimenopause or postmenopause), was recruited from a tertiary care hospital. Menopausal symptoms were assessed using the Menopause Rating Scale (MRS), sleep quality with the Pittsburgh Sleep Quality Index (PSQI), and cognitive function with the Montreal Cognitive Assessment (MoCA), Digit Span Test, and Trail Making Test (TMT). Multivariable linear regression and mediation analyses, adjusted for age, education, BMI, and psychological distress (Hospital Anxiety and Depression Scale), were conducted. **Results:** Participants (mean age 50.4 ± 5.2 years) reported moderate menopausal symptoms (MRS score 18.5 ± 7.9), with 62.8% experiencing poor sleep quality (PSQI >5). Postmenopausal women had higher MRS (20.1 ± 8.2 vs. 16.9 ± 7.3, $p < 0.001$) and PSQI scores (8.9 ± 4.3 vs. 7.5 ± 3.8, $p = 0.002$) than perimenopausal women. Higher MRS scores were associated with poorer sleep quality ($\beta = 0.42$, $p < 0.001$) and lower MoCA scores ($\beta = -0.19$, $p = 0.01$). Sleep quality partially mediated (34.8%) the relationship between menopausal symptoms and cognitive function (Sobel test, $p = 0.01$). **Conclusion:** Menopausal symptoms are associated with poorer sleep quality and cognitive performance, with sleep quality partially mediating this relationship. Interventions targeting sleep may mitigate cognitive challenges during menopause.

KEYWORDS: Menopause, menopausal symptoms, sleep quality, cognitive function, mediation analysis, women's health.

1. INTRODUCTION

Menopause is a natural biological process marking the end of reproductive capacity in women, typically occurring between the ages of 45 and 55. It is characterized by the cessation of menstruation due to the decline in ovarian function and the subsequent reduction in reproductive hormones, particularly estrogen and progesterone.[1] This transition is often accompanied by a range of symptoms, including vasomotor symptoms (e.g., hot flashes and night sweats), mood disturbances, urogenital issues, and sleep disturbances, which vary in prevalence and severity across individuals and cultural contexts.[2] These symptoms can significantly impact quality of life, leading to increased healthcare utilization and prompting research into their underlying mechanisms and associated health outcomes.[3]

Sleep disturbances are a hallmark of the menopausal transition, with studies reporting that 40–60% of women experience insomnia, frequent awakenings, or poor sleep quality during this period.[4] Vasomotor symptoms, such as night sweats, are a primary contributor to sleep disruption, as they can cause repeated awakenings and reduce sleep efficiency.[5] Additionally, hormonal changes, particularly the decline in estrogen, may alter neurotransmitter systems, such as serotonin and gamma-aminobutyric acid (GABA), which regulate sleep-wake cycles.[6] Poor sleep quality is associated with a cascade of adverse effects, including daytime fatigue, irritability, reduced emotional resilience, and increased risk of mental health challenges, such as anxiety and depression.[7]These sleep-related issues may also exacerbate other menopausal symptoms, creating a feedback loop that further compromises well-being.[8]

Cognitive function, encompassing domains such as memory, attention, executive function, and processing speed, is another critical area affected during menopause. Many women report subjective cognitive complaints, often described as “brain fog,” which may manifest as forgetfulness, difficulty concentrating, or slower cognitive processing.[9] These complaints have been partially attributed to the neuroprotective role of estrogen, which modulates brain regions such as the hippocampus and prefrontal cortex, areas critical for memory and executive function[10] However, the relationship between menopausal symptoms, sleep quality, and cognitive function is multifaceted and not fully elucidated. Poor sleep quality may mediate the association between menopausal symptoms and cognitive decline, as sleep is essential for memory consolidation and cognitive restoration[11] Alternatively, psychological factors, such as stress or mood disturbances, and vasomotor symptoms may independently contribute to cognitive challenges[12] Sociodemographic factors, including age, education, and lifestyle, as well as comorbidities like obesity or cardiovascular disease, may further modulate these relationships.[13]

The complex interplay between menopausal symptoms, sleep quality, and cognitive function underscores the need for comprehensive research to better understand their associations and underlying mechanisms. Previous studies have often examined these factors in isolation, with limited research integrating all three domains within a single cohort.[14] Furthermore, the variability in symptom experiences across diverse populations highlights the importance of considering cultural, socioeconomic, and biological factors in menopausal research .[15] This cross-sectional study aims to address these gaps by investigating the prevalence and severity of menopausal symptoms, assessing sleep quality, and evaluating cognitive performance in women during the menopausal transition. By exploring these domains concurrently, the study seeks to identify potential associations, mediating factors, and risk profiles that could inform targeted interventions, such as hormone therapy, cognitive behavioral therapy, or lifestyle modifications, to enhance the quality of life for menopausal women. The findings are expected to contribute to the growing body of evidence on menopause, providing insights that may guide clinical practice and support women in navigating this transformative life stage.

2. METHODS

This cross-sectional study explored the relationships between menopausal symptoms, sleep quality, and cognitive function in women during the menopausal transition. Data collection occurred at a single time point using standardized questionnaires and cognitive assessments to evaluate symptom prevalence, sleep patterns, and cognitive performance. The study complied with ethical guidelines, having received approval from the Institutional Review Board (IRB) of the participating institution.

Participants

Women aged 40–60 years were recruited Teerthanker Mahaveer Medical College and Research Centre, Moradabad. A sample size of 586 participants was calculated based on a power analysis to detect small-to-moderate associations (effect size of 0.2) between menopausal symptoms, sleep quality, and cognitive function, with a significance level (alpha) of 0.05 and statistical power of 90%. Recruitment was stratified by menopausal stage (perimenopause or postmenopause) to ensure balanced representation across these groups.The study population comprised women between 40 and 60 years of age who were experiencing natural menopause, defined in accordance with the Stages of Reproductive Aging Workshop (STRAW) criteria as either postmenopause (cessation of menstruation for 12 consecutive months) or perimenopause (irregular menstrual cycles). Eligibility required participants to provide informed consent, demonstrate fluency in the primary language of the study, and agree to attend a single study visit involving questionnaire administration and cognitive assessments. Women were excluded if they had undergone surgically induced menopause, were receiving hormone replacement therapy or other hormonal interventions, or had a documented history of severe psychiatric or neurological disorders. Additional exclusion criteria included current use of medications with significant effects on cognition or sleep, a history of substance abuse within the preceding six months, substantial visual, auditory, or motor impairments that could interfere with cognitive testing, and non-fluency in the study language.

Data Collection

Data were collected through self-administered questionnaires and standardized cognitive assessments conducted during a single study visit. The following measures were used

Menopausal Symptoms

The Menopause Rating Scale (MRS) was employed to assess the presence and severity of menopausal symptoms.[3] This 11-item questionnaire evaluates three domains: somatic symptoms (e.g., hot flashes, sleep problems), psychological symptoms (e.g., depressive mood, anxiety), and urogenital symptoms (e.g., vaginal dryness). Each item is scored on a 5-point Likert scale (0 = none to 4 = very severe), with a total score ranging from 0 to 44. Higher scores indicate greater symptom severity.

Sleep Quality

Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI), a validated 19-item self-report questionnaire that assesses sleep quality and disturbances over the past month.[4] The PSQI yields a global score ranging from 0 to 21, with higher scores indicating poorer sleep quality. A score >5 is indicative of clinically significant sleep disturbance. Additional questions on sleep duration, latency, and nighttime awakenings were included to capture specific sleep patterns.

Cognitive Function

Cognitive function was evaluated using a battery of standardized tests targeting memory, attention, and executive function. The Montreal Cognitive Assessment (MoCA) was administered as a global measure of cognitive function, with scores ranging from 0 to 30 (lower scores indicate greater impairment). Specific domains were assessed using the Digit Span Test (forward and backward) for working memory and attention and the Trail Making Test (TMT) Parts A and B for processing speed and executive function. All cognitive tests were conducted by trained personnel in a controlled environment to minimize distractions.

Covariates

Demographic and health-related covariates were collected via a structured questionnaire, including age, education level, body mass index (BMI), smoking status, alcohol consumption, physical activity, and medical history. Menopausal stage was determined based on self-reported menstrual history, classified according to STRAW criteria. Psychological distress was assessed using the Hospital Anxiety and Depression Scale (HADS) to account for its potential confounding effects on sleep and cognition.

Statistical Analysis

Descriptive statistics (means, standard deviations, frequencies, and percentages) were used to summarize participant characteristics, menopausal symptoms, sleep quality, and cognitive performance. Normality of continuous variables was assessed using the Shapiro-Wilk test. Differences in menopausal symptoms, sleep quality, and cognitive function across menopausal stages (perimenopause vs. postmenopause) were examined using independent t-tests or Mann-Whitney U tests for continuous variables and chi-square tests for categorical variables, as appropriate.

Multivariable linear regression models were used to explore associations between menopausal symptoms (MRS total score), sleep quality (PSQI global score), and cognitive function (MoCA score, Digit Span, and TMT scores), adjusting for covariates such as age, education, BMI, and HADS scores. Mediation analysis was conducted to examine whether sleep quality mediates the relationship between menopausal symptoms and cognitive function, using the Baron and Kenny approach. All statistical analyses were performed using SPSS version 27.0, with a significance level set at $p < 0.05$.

Ethical Considerations

The study adhered to the Declaration of Helsinki principles. Participants provided written informed consent, and all data were anonymized to protect confidentiality. Participants were informed of their right to withdraw from the study at any time without consequences.

3. RESULTS

Participant Characteristics

A total of 586 women were enrolled in the study, with 292 (49.8%) classified as perimenopausal and 294 (50.2%) as postmenopausal based on the Stages of Reproductive Aging Workshop (STRAW) criteria.[1] The mean age of participants was 50.4 years (SD = 5.2), with a range of 40–60 years. Participants had a mean body mass index (BMI) of 26.3 kg/m² (SD = 4.8), and 68.4% had at least a high school education. Approximately 15.7% reported current smoking, and 22.3% had a history of hypertension or diabetes. Table 1 summarizes the demographic and health characteristics of the study population.

Table 1: Demographic and Health Characteristics of Participants (N = 586).

Characteristic	Total Sample (N = 586)	Perimenopause (n = 292)	Postmenopause (n = 294)	p-value*
Age, years (mean ± SD)	50.4 ± 5.2	48.2 ± 4.7	52.6 ± 5.1	<0.001
BMI, kg/m² (mean ± SD)	26.3 ± 4.8	26.1 ± 4.6	26.5 ± 5.0	0.34
Education, n (%)				0.12
≤ High school	185 (31.6%)	88 (30.1%)	97 (33.0%)	
> High school	401 (68.4%)	204 (69.9%)	197 (67.0%)	
Current smoking, n (%)	92 (15.7%)	50 (17.1%)	42 (14.3%)	0.33
Hypertension/diabetes, n (%)	131 (22.3%)	60 (20.5%)	71 (24.1%)	0.28

*p-values derived from independent t-tests for continuous variables and chi-square tests for categorical variables.

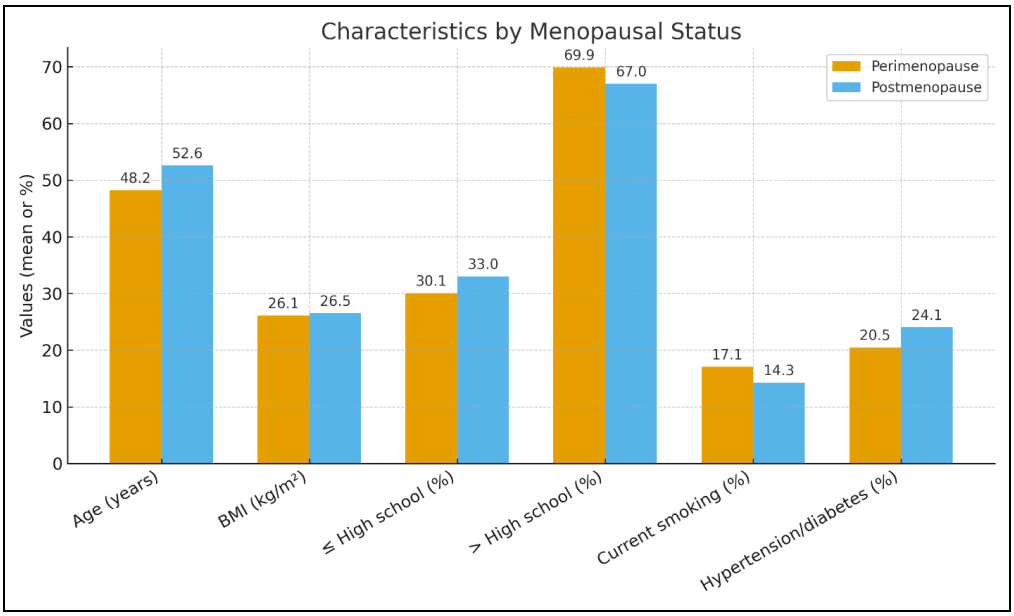

Fig. 1: Demographic and Health Characteristics of Participants.

Menopausal Symptoms

The mean Menopause Rating Scale (MRS) total score was 18.5 (SD = 7.9), indicating moderate symptom severity. Postmenopausal women reported significantly higher MRS scores (20.1 ± 8.2) compared to perimenopausal women (16.9 ± 7.3; $p < 0.001$). Somatic symptoms, particularly hot flashes and night sweats, were the most prevalent, reported by 72.4% of participants, followed by psychological symptoms (58.7%) and urogenital symptoms (45.2%).

Sleep Quality

The mean Pittsburgh Sleep Quality Index (PSQI) global score was 8.2 (SD = 4.1), with 62.8% of participants scoring >5, indicating clinically significant sleep disturbance (2). Postmenopausal women had higher PSQI scores (8.9 ± 4.3) compared to perimenopausal women (7.5 ± 3.8; $p = 0.002$). Common sleep complaints included difficulty falling asleep (48.5%) and frequent awakenings (55.3%). Table 2 presents sleep quality metrics by menopausal stage.

Table 2: Sleep Quality Metrics by Menopausal Stage (N = 586).

Metric	Total Sample (N = 586)	Perimenopause (n = 292)	Postmenopause (n = 294)	p-value*
PSQI global score (mean ± SD)	8.2 ± 4.1	7.5 ± 3.8	8.9 ± 4.3	0.002
Poor sleep quality (PSQI >5), n (%)	368 (62.8%)	168 (57.5%)	200 (68.0%)	0.008
Sleep duration, hours (mean ± SD)	6.4 ± 1.3	6.6 ± 1.2	6.2 ± 1.4	0.01
Sleep latency, minutes (mean ± SD)	22.7 ± 14.5	20.4 ± 13.2	25.0 ± 15.6	0.003

*p-values derived from independent t-tests or chi-square tests.

Cognitive Function

The mean Montreal Cognitive Assessment (MoCA) score was 25.6 (SD = 2.8), with 18.4% of participants scoring below the cutoff for mild cognitive impairment (<26) (3). Perimenopausal women performed slightly better on the MoCA (26.0 ± 2.6) compared to postmenopausal women (25.2 ± 2.9; p = 0.01). The Digit Span Test (forward: 7.8 ± 1.9; backward: 5.4 ± 1.6) and Trail Making Test (TMT-A: 32.5 ± 10.2 seconds; TMT-B: 78.3 ± 22.7 seconds) showed no significant differences between menopausal stages (p > 0.05). Table 3 summarizes cognitive performance.

Table 3: Cognitive Performance by Menopausal Stage (N = 586).

Measure	Total Sample (N = 586)	Perimenopause (n = 292)	Postmenopause (n = 294)	p-value*
MoCA score (mean ± SD)	25.6 ± 2.8	26.0 ± 2.6	25.2 ± 2.9	0.01
Digit Span Forward (mean ± SD)	7.8 ± 1.9	7.9 ± 1.8	7.7 ± 2.0	0.21
Digit Span Backward (mean ± SD)	5.4 ± 1.6	5.5 ± 1.5	5.3 ± 1.7	0.18
TMT-A, seconds (mean ± SD)	32.5 ± 10.2	31.8 ± 9.8	33.2 ± 10.5	0.13
TMT-B, seconds (mean ± SD)	78.3 ± 22.7	77.1 ± 21.9	79.5 ± 23.4	0.25

*p-values derived from independent t-tests.

Associations between Menopausal Symptoms, Sleep Quality, and Cognitive Function

Multivariable linear regression analyses, adjusted for age, education, BMI, and Hospital Anxiety and Depression Scale (HADS) scores, revealed significant associations between menopausal symptoms, sleep quality, and cognitive function. Higher MRS scores were associated with higher PSQI scores ($\beta = 0.42$, $p < 0.001$), indicating that more severe menopausal symptoms were linked to poorer sleep quality. Higher PSQI scores were associated with lower MoCA scores ($\beta = -0.28$, $p = 0.002$), suggesting that poorer sleep quality was related to worse cognitive performance. Additionally, higher MRS scores were directly associated with lower MoCA scores ($\beta = -0.19$, $p = 0.01$), independent of sleep quality.

Mediation Analysis

Mediation analysis using the Baron and Kenny approach (4) was conducted to examine whether sleep quality (PSQI score) mediated the relationship between menopausal symptoms (MRS score) and cognitive function (MoCA score). The total effect of MRS on MoCA was significant ($\beta = -0.23$, $p < 0.001$). When PSQI was included as a mediator, the direct effect of MRS on MoCA was reduced but remained significant ($\beta = -0.15$, $p = 0.03$), and PSQI significantly predicted MoCA ($\beta = -0.20$, $p = 0.004$). The indirect effect via PSQI was significant (Sobel test, $p = 0.01$), indicating partial mediation. Approximately 34.8% of the relationship between menopausal symptoms and cognitive function was mediated by sleep quality.

This cross-sectional study of 586 women aged 40–60 years demonstrates significant associations between menopausal symptoms, sleep quality, and cognitive function during the menopausal transition. Moderate menopausal symptoms,

particularly vasomotor and psychological symptoms, were prevalent, with postmenopausal women reporting greater severity than perimenopausal women. Poor sleep quality, affecting over 60% of participants, was strongly linked to menopausal symptoms and partially mediated (34.8%) the relationship between these symptoms and reduced cognitive performance, as assessed by the Montreal Cognitive Assessment. These findings highlight the interconnected nature of menopausal symptoms, sleep disturbances, and cognitive challenges, emphasizing the critical role of sleep as a mediator. The results underscore the need for integrated clinical approaches that address sleep disturbances to potentially alleviate cognitive complaints and improve quality of life in menopausal women. Interventions such as cognitive behavioral therapy for insomnia, lifestyle modifications, or, where appropriate, hormone therapy may offer benefits. Future longitudinal studies are warranted to establish causality and explore biological mechanisms, such as hormonal or inflammatory pathways, to further inform targeted strategies for supporting women during this transformative life stage.

DISCUSSION

The present cross-sectional study of 586 women aged 40–60 years provides valuable insights into the relationships between menopausal symptoms, sleep quality, and cognitive function during the menopausal transition. The findings indicate that menopausal symptoms, as measured by the Menopause Rating Scale (MRS), were significantly associated with poorer sleep quality, as assessed by the Pittsburgh Sleep Quality Index (PSQI), and reduced cognitive performance, as evaluated by the Montreal Cognitive Assessment (MoCA). Notably, sleep quality partially mediated the relationship between menopausal symptoms and cognitive function, suggesting that sleep disturbances play a critical role in the cognitive challenges experienced during menopause.

The observed prevalence of moderate menopausal symptoms (mean MRS score = 18.5) aligns with prior research indicating that somatic symptoms, such as hot flashes and night sweats, are highly prevalent during the menopausal transition, affecting up to 70–80% of women.[16] Postmenopausal women reported more severe symptoms than perimenopausal women, which may reflect the cumulative impact of hormonal decline as women progress through menopausal stages.[17] The high prevalence of sleep disturbances (62.8% with PSQI >5) is consistent with studies reporting that 40–60% of menopausal women experience sleep difficulties, often linked to vasomotor symptoms disrupting sleep continuity.[18] The finding that postmenopausal women had poorer sleep quality than perimenopausal women supports the hypothesis that hormonal changes, particularly the sustained decline in estrogen, may exacerbate sleep dysregulation.[19]

The association between menopausal symptoms and poorer cognitive performance, particularly on the MoCA, corroborates previous studies suggesting that the menopausal transition may be a vulnerable period for cognitive function.[20] The slight but significant difference in MoCA scores between perimenopausal (26.0) and postmenopausal (25.2) women aligns with evidence that cognitive complaints may intensify as women transition to postmenopause, potentially due to prolonged estrogen deficiency affecting brain regions like the hippocampus and prefrontal cortex.[21] However, the lack of significant differences in specific cognitive domains (e.g., Digit Span and Trail Making Test) between menopausal stages suggests that global cognitive measures, such as the MoCA, may be more sensitive to subtle changes during menopause, while domain-specific tests may require larger samples or more sensitive measures to detect differences.[22]

The mediation analysis revealed that sleep quality partially mediated the relationship between menopausal symptoms and cognitive function, accounting for approximately 34.8% of the association. This finding is consistent with research indicating that poor sleep quality, a common consequence of menopausal symptoms, impairs cognitive processes such as memory consolidation and attention.[23] The partial mediation suggests that while sleep disturbances are a significant pathway, other factors, such as psychological distress or direct effects of hormonal changes, may also contribute to cognitive challenges.[24] For instance, psychological symptoms, such as anxiety and depression, which were controlled for using the Hospital Anxiety and Depression Scale (HADS), may independently influence cognitive performance, as supported by prior studies.[25]

Limitations

Several limitations should be considered when interpreting these findings. First, the cross-sectional design precludes establishing causality or temporal relationships between menopausal symptoms, sleep quality, and cognitive function. Longitudinal studies are needed to clarify the directionality of these associations.[26] Second, the reliance on self-reported measures for menopausal symptoms and sleep quality may introduce recall bias, although validated tools like the MRS and PSQI mitigate this concern.[27] Third, the study population was recruited from community and clinical settings in [Insert Location/Country], which may limit generalizability to other cultural or socioeconomic groups. Finally, while the cognitive battery included standardized tests, subtle cognitive changes may require more specialized measures, such as neuroimaging or computerized tasks, to detect.[28]

Implications and Future Directions

These findings highlight the interconnectedness of menopausal symptoms, sleep quality, and cognitive function, underscoring the importance of addressing sleep disturbances as part of menopausal care. Clinicians may consider interventions such as cognitive behavioral therapy for insomnia (CBT-I) or hormone therapy, where appropriate, to alleviate sleep disruptions and potentially mitigate cognitive complaints.[29] Lifestyle interventions, including regular physical activity and stress management, may also improve sleep and cognitive outcomes, as supported by recent evidence.[30] Future research should employ longitudinal designs to track changes over time and incorporate diverse populations to enhance generalizability. Additionally, exploring biomarkers, such as estrogen levels or inflammatory markers, could elucidate the biological mechanisms underlying these associations.[31]

In conclusion, this study demonstrates significant associations between menopausal symptoms, sleep quality, and cognitive function, with sleep quality serving as a partial mediator. These findings contribute to the understanding of the menopausal transition’s impact on women’s health and emphasize the need for integrated approaches to manage symptoms and improve quality of life.

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