DOI: 10.21088/potj.0974.5777.18125.2

Physiotherapy and Occupational Therapy Journal
Volume 18 Number 1, January - March 2025

ORIGINAL ARTICLE

Smartphone Addiction, Sleep Quality, and Central Sensitization in Chronic Musculoskeletal Pain of the Cervical Spine and Upper Limbs

Bid Dibyendunarayan Dhrubaprasad[1], Thangamani Ramalingam A.[2], Dhamesha Yesha Anil[3], Radadiya Prathistha Kaushik[4], Jujavadiya Drashti Ajaykumar[5], Monpara Anjali Dineshbhai[6]

HOW TO CITE THIS ARTICLE:

Bid Dibyendunarayan Dhrubaprasad, *et al.* Smartphone Addiction, Sleep Quality, and Central Sensitization in Chronic Musculoskeletal Pain of the Cervical Spine and Upper Limbs. Physio. and Occ. Therapy Jr. 2025; 18(1): 11-18.

ABSTRACT

Background: Chronic musculoskeletal pain significantly affects an individual's well-being and daily functioning. Excessive smartphone use has been linked to the development of musculoskeletal pain, poor sleep quality, and central sensitization of the cervical spine and upper limbs.

Aim: This study aimed to investigate the effects of smartphone addiction on poor sleep quality and central sensitization in individuals with chronic cervical spine and upper limb musculoskeletal pain.

Objective: The objective of the study was to investigate the relationship between smartphone addiction, sleep quality, and central sensitization in individuals with chronic musculoskeletal pain in the cervical spine and upper limbs.

Methods and Materials: A cross-sectional observational design was employed, with 300 participants. Data on smartphone addiction, sleep quality, and central sensitization were collected using validated questionnaires: Smartphone Addiction Score-Short Version (SAS-SV), Central Sensitization Inventory-Gujarati (CSI-G), and Pittsburgh Sleep Quality Index (PISQI). In addition, hours of smartphone usage and pain level were measured on a numerical pain rating scale.

Results: Significant correlations were identified between smartphone addiction, sleep quality, and central sensitization. A statistically significant Pearson correlation coefficient was found between scores of SAS-SV and CSI 0.495 ($p = 0.001$), SAS-SV and PISQI 0.285 ($p = 0.001$), SAS-SV and the Hours of Smartphone usage 0.716 ($p = 0.001$), and SAS-SV and the Numeric Pain Rating Scale (NPRS) 0.417 ($p = 0.001$).

AUTHOR'S AFFILIATION:

[1-2] The Sarvajanik College of Physiotherapy, Rampura, Surat, Gujarat, India.
[3-6] Physiotherapists, Private Practitioner, Surat, Gujarat, India.

CORRESPONDING AUTHOR:

Bid Dibyendunarayan Dhrubaprasad, The Sarvajanik College of Physiotherapy, Rampura, Surat, Gujarat, India.
E-mail: dnbid71@gmail.com

➢ **Received:** 08-01-2025 ➢ **Revised:** 18-02-2025 ➢ **Accepted:** 21-03-2025

Conclusions: This study found a significant relationship between smartphone addiction, poor sleep quality, and central sensitization in individuals with chronic musculoskeletal pain of the cervical spine and upper limbs. These results suggest that excessive smartphone use and sleep disturbances may contribute to the development of central sensitization, impacting pain levels and overall well-being.

KEY MESSAGE

There is a connection among smartphone addiction, poor sleep quality, and central sensitization in individuals with chronic musculoskeletal pain.

KEYWORDS

• Smartphone Addiction • Sleep Quality • Central Sensitization • Musculoskeletal Pain • Neck and Shoulder Pain • Upper limb pain

INTRODUCTION

Chronic musculoskeletal pain significantly affects individuals' daily lives and overall well-being. Musculoskeletal pain is defined as acute or chronic pain that affects bones, muscles, ligaments, tendons, and nerves. Pain associated with musculoskeletal disorders (MSK) is a common medical and socioeconomic problem worldwide.[1] Chronic musculoskeletal pain is defined as pain perceived in musculoskeletal tissues that lasts or recurs for more than three months and is characterized by significant functional disability and emotional distress. [2] Excessive smartphone use can lead to musculoskeletal pain in the neck and upper limbs. Signs of smartphone addiction (SA) include difficulty in cutting back on usage, neglecting responsibilities, preoccupation with the device, withdrawal symptoms, and negative impacts on daily life or relationships. If smartphone use interferes with work, school, or personal life, it may indicate addiction with symptoms, such as anxiety or irritability.[3] The Smartphone Addiction Scale-Short Version (SAS-SV) was developed and validated to quantify the severity of smartphone addiction. Existing literature demonstrates associations between SA and mental health[4], physical health[5], and neurological problems[6]. However, this evidence is not conclusive[7]. However, there is debate in the literature about the positive or negative relationship between the amount of screen time or smartphone use and health outcomes. The smartphone addiction score (SAS-SV) has been found to have good reliability and validity. A score of 22 or below indicated no addiction and a score of 34 or above indicated potential addiction.[8] Poor sleep quality and smartphone addiction have emerged as significant factors contributing to the development of central sensitization in patients with chronic musculoskeletal pain. Moreover, excessive smartphone use, often accompanied by poor sleep habits, leads to prolonged sedentary behavior and increased musculoskeletal strain, further exacerbating pain symptoms.[9]

Poor sleep quality is one of the critical mechanisms linking smartphone addiction to musculoskeletal pain. Excessive smartphone use, especially before bedtime, can disrupt sleep patterns and reduce the overall sleep quality. Poor sleep quality is a known risk factor for central sensitization (CS), a phenomenon characterized by the increased sensitivity of the central nervous system to pain stimuli. CS is commonly observed in individuals with chronic pain conditions, including CMP, and is associated with amplified pain perception and reduced pain threshold.

Additionally, prolonged sedentary behavior and postural strain caused by excessive smartphone use further exacerbate musculoskeletal issues. Holding a smartphone for extended periods often results in a forward head posture, sustained neck flexion, and repetitive strain on the upper limbs. When combined with poor sleep quality and potential CS, these physical stressors create a complex interplay that intensifies pain symptoms and diminishes quality of life.

Despite these findings, there remains a gap in our understanding of the direct relationships among smartphone addiction, sleep quality, and central sensitization in individuals with chronic musculoskeletal pain. Most existing studies have focused on the isolated aspects

of these variables without comprehensively examining their interconnected effects.

The aims and objectives of this study were to examine the association between smartphone addiction, poor sleep quality, and central sensitization in individuals with chronic musculoskeletal pain in the cervical spine and upper limbs. It is hypothesized that there is a positive correlation between smartphone addiction and poor sleep quality and the occurrence of central sensitization (CS) among individuals afflicted with chronic cervical spine and upper-limb musculoskeletal pain.

MATERIAL AND METHODS

A cross-sectional observational study was conducted at The Sarvajanik College of Physiotherapy in Surat, with a sample size of 300 individuals recruited through convenience sampling. The participants were between 18 and 40 years of age and were diagnosed with chronic cervical spine and upper limb musculoskeletal pain. Exclusion criteria included recent surgery or corticosteroid use, high BMI, or systemic inflammatory arthritis. Assessments of smartphone addiction, sleep quality, and central sensitization were conducted using the SAS-SV, PSQI-G, and CSI-G, respectively.

The Smartphone Addiction Scale-Short Version (SAS-SV) is a reliable and valid tool for assessing smartphone addiction with high internal consistency and strong construct validity. It correlates significantly with other measures of problematic smartphone use and effectively distinguishes between high and low addiction levels. [10-13]

The Pittsburgh Sleep Quality Index (PSQI) is a widely used self-report questionnaire that evaluates sleep quality and disturbances over a month, providing a global score that reflects overall sleep quality. It is reliable, with strong internal consistency and test-retest reliability across populations. The PSQI shows strong validity, correlating well with objective measures, such as polysomnography and actigraphy. It is extensively used in clinical and research settings to identify sleep disorders and to monitor treatment outcomes. [14-17]

The Central Sensitization Inventory (CSI) is considered a reliable and valid tool for identifying individuals with potential central sensitization (CS), demonstrating strong psychometric properties, including high test-retest reliability, good internal consistency, and construct validity, making it useful for screening patients with chronic pain conditions where CS may be a contributing factor.[18-22]

Ethical approval was obtained from the Institutional Ethics Committee of The Sarvajanik College of Physiotherapy, Surat, where questionnaires were distributed to eligible patients, informed consent was obtained, and the data were analyzed. Data collection took place over four months from December 2023 to March 2024.

The data were cleaned and checked for normality using the Kolmogorov–Smirnov test. Descriptive analysis was performed as frequencies for categorical variables and means and standard deviations for continuous variables. Bivariate Pearson moment correlation was performed for the outcome variables. All analyses were conducted using SPSS 20.0, IBM, Armonk, NY, USA, with 95% confidence interval (CI) limits and a p-value of <0.05, which was considered statistically significant. Table 1 presents a summary of the demographic and health-related variables.

RESULTS

This study involved 300 participants, with 131 male participants, comprising 77 young adults (aged 18-25) and 54 adults (aged 26-40). Among the participants, 169 were female, with 104 in the young adult category (aged 18-25) and 65 in the adult category (aged 26-40). In this study, 102 males (34%) and 130 females (43.33%) were addicted to smartphones. In this study, 96 male (32%) and 132 female (44%) exhibited central sensitization, as indicated by the Central Sensitization Inventory scores falling within the range of 40-100. In this study, 125 male (41.66%) and 161 female (53.66%) displayed poor sleep quality, as determined by the Pittsburgh Sleep Quality Index (PSQI). In this study, among non-addicted smartphone users, 39 out of 68 participants demonstrated the presence of CS. Conversely, 189 of the 232 smartphone addicts exhibited CS.

Table 1: Demographic and health-related data

Variables	Mean	Std. Deviation
Age (Years)	25.43	5.15
Height (cm)	168.84	11.55
Weight (Kgs)	62.41	11.21
Duration of Musculoskeletal Pain (In Months)	9.96	11.62
CSI Total	48.38	14.29
NPRS Level	4.92	0.91
Hours of Smartphone Used	4.99	1.59
SAS SV Total	37.16	8.17
PSQI Total	10.35	3.13

Table 2: Cross-tabulation of SAS-SV Categories and CSI Categories

Sub Clinical		CSI Categories					Total
		Mild	Moderate	Severe	Extreme		
SAS Category	Not Addicted <30	8	21	26	11	2	68
	Addicted >30	16	27	75	60	54	232
	Total	24	48	101	71	56	300

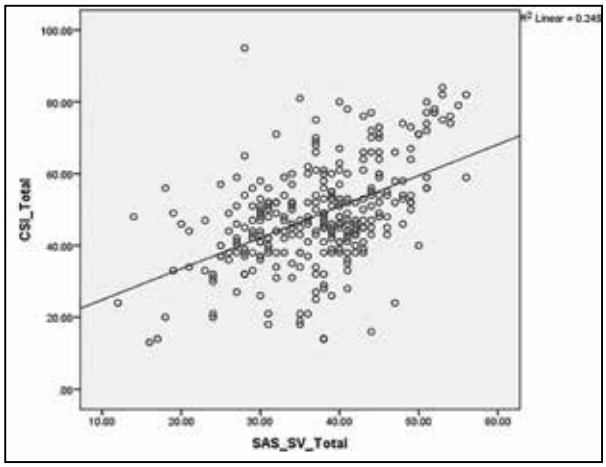
Table 1 summarizes the demographic and health-related data, while Table 2 presents a cross-tabulation of the SAS-SV categories with CSI categories. In this study, an SAS-SV score <30 was considered "not addicted" and >30 scores were considered "Addicted."

Table 3: Correlation of Outcome Measures (N=300)

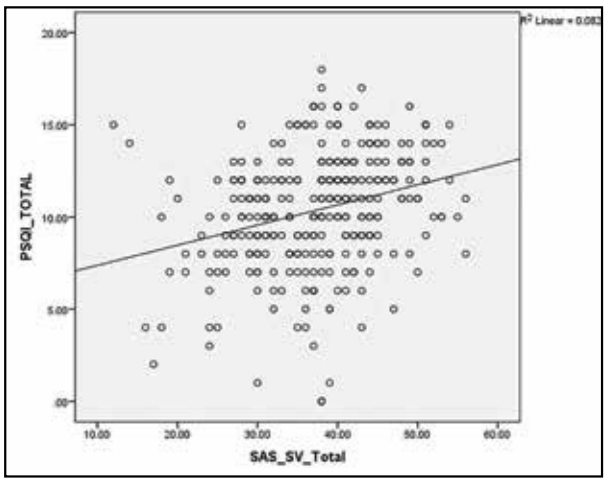
Outcome Measures	CSI Total	SAS-SV Total	PSQI Total	Hours of Smartphone Used
NPRS Level	.335**	.417**	.335**	.253**
	<0.001	<0.001	<0.001	<0.001
CSI Total	1	.495**	.351**	.362**
		<0.001	<0.001	<0.001
SAS-SV Total		1	.285**	.716**
			<0.001	<0.001
PSQI Total			1	.102
				.078

**. Correlation is significant at the 0.01 level (2-tailed).

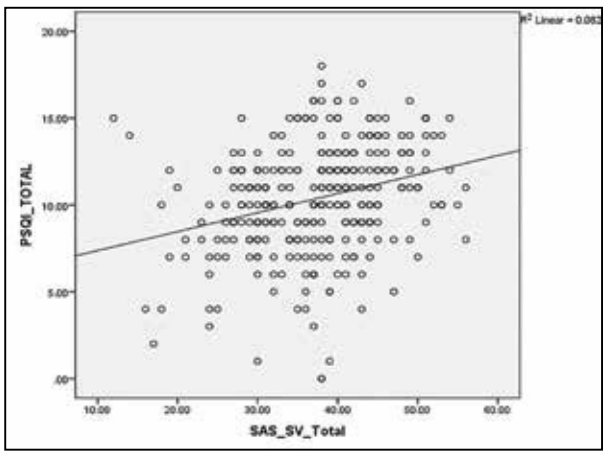
Correlation analysis (Table 3) revealed significant associations between SAS-SV, CSI, PSQI, and smartphone usage hours.



Graph 1: Scatter Plot of SAS-SV Total vs. CSI Total Scores



Graph 2: Scatter Plot of SAS-SV Total vs. PSQI Total Scores



Graph 3: Scatter Plot of PSQI Total vs. CSI Total Scores

The scatter plots (Graphs 1-3) further illustrate the positive correlations between these variables.

DISCUSSION

This study sheds light on the intricate relationship between smartphone addiction (SA), sleep quality, and central sensitization (CS) in individuals experiencing chronic musculoskeletal (MSK) pain in the cervical spine and upper limbs. The findings revealed that smartphone addiction is significantly associated with poor sleep quality and increased central sensitization, suggesting a cyclical interplay that exacerbates chronic pain symptoms. Among smartphone-addicted participants, the majority reported poor sleep quality and showed evidence of CS. These results are consistent with those of Ahmed *et al.*[23], who highlighted the detrimental effects of excessive smartphone use on MSK pain, particularly in the neck, shoulders, and upper limbs. Similarly, Mustafaoglu *et al.*[24] emphasized the prevalence of MSK pain in the upper back, neck, and wrists/hands among smartphone users, with those addicted to smartphones demonstrating a higher risk.

The significant association observed between SA and CS in this study emphasizes the neurological consequences of excessive smartphone use (Graph-1). The moderate positive correlation between these variables [20,25] suggests that SA may contribute to the development or exacerbation of CS, a condition characterized by heightened nervous system sensitivity to pain. This phenomenon aligns with the findings of Tuğral and Yağmur[26], who posited that smartphone use could amplify central sensitization by promoting repetitive strain and sedentary behavior. The altered muscle activation patterns observed in individuals with shoulder pain[27,28] further support this association, indicating that the postural and mechanical stresses associated with smartphone use may trigger central sensitization in susceptible individuals.

Sleep quality was a critical factor in the present study, reinforcing the role of restorative sleep in the management of chronic pain. Poor sleep is widely recognized as a contributor to both physiological and psychological stress, which can exacerbate pain perception and sensitivity. Participants with higher SA scores consistently reported poorer sleep quality, highlighting the interconnected nature of SA and sleep disruption (Graph-2). These findings align with those of Alhafi *et al.*[29], who

found that smartphone addiction is strongly associated with poor sleep quality, with the majority of smartphone-addicted individuals experiencing sleep disturbances. Studies have also shown that SA worsens sleep efficiency, increases sleep disturbances, and contributes to daytime dysfunction[30][29]. Similarly, Filho *et al*.[31] demonstrated that patients with signs of CS had higher rates of sleep disturbances such as nocturnal awakenings and sleep apnea, further linking poor sleep quality to heightened central sensitivity.

The bidirectional relationship between sleep quality and CS was particularly notable (Graph-3). Disrupted sleep patterns can amplify the nervous system's sensitivity to pain, whereas heightened pain sensitivity associated with CS can further disrupt sleep. This self-reinforcing cycle underscores the need for comprehensive interventions targeting both sleep quality and central sensitization in individuals with chronic MSK pain. Addressing these factors holistically is critical for breaking the pain cycle, disrupting sleep, and heightening neural sensitivity.

In addition to its implications for pain management, this study highlights the broader psychosocial consequences of SA. Research has shown that individuals predisposed to SA often experience higher levels of anxiety, reduced engagement in daily activities, and prolonged sleep latencies[32]. Furthermore, early initiation of smartphone use has been linked to greater dependence and excessive usage, potentially increasing the risk of developing SA and its associated consequences. Another study[33] found that poor sleep quality was positively correlated with shoulder pain, disability, and SA, suggesting that these factors collectively contribute to increased pain and functional impairment. Similarly, a cross-sectional study[34] of university students found that SA was associated with poor sleep quality and reduced mental well-being, further emphasizing the interconnected nature of these variables.

These findings suggest a pressing need for targeted interventions addressing SA to mitigate its impact on sleep quality and CS. Ergonomic education, behavioral strategies to reduce smartphone use, and sleep hygiene promotion should be incorporated into the therapeutic protocols for individuals with chronic MSK pain.

Longitudinal studies are necessary to establish the causal pathways between SA, sleep quality, and CS. Additionally, mediation analyses can explore the role of sleep quality as an intermediary in the relationship between SA and CS. Intervention-based research evaluating the efficacy of behavioral, ergonomic, and sleep-focused strategies in reducing SA and mitigating its impact on CS and chronic pain is warranted.

Self-reported measures may introduce reporting biases, and convenience sampling methods may affect generalizability.

CONCLUSION

This study highlights the significant occurrence of smartphone addiction in individuals with chronic cervical spine and upper limb pain, which is strongly linked to poor sleep quality and central sensitization. These interconnected factors worsen the pain and well-being. Addressing these issues requires ergonomic education, sleep hygiene promotion, and targeted interventions for central sensitization.

Conflict of Interest: None

Funding: Self-financed

Ethics Declaration:

The study was approved by the Institutional Ethics Committee of the Sarvajanik College of Physiotherapy, Rampura, Surat, and informed consent was obtained from all participants to ensure confidentiality.

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