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Association Between Socrates Pain Dimensions and Sleep Quality in Orthopedic Operative Patients: An Observational Study

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ABSTRACT

Introduction: *Postoperative pain is a frequent complication after orthopedic surgery and is closely linked to sleep disturbances, which can slow recovery and impair quality of life. The SOCRATES framework assesses multiple pain dimensions beyond intensity, providing deeper insights into pain–sleep interactions.*

Aim and Objectives: *To assess the association between SOCRATES pain dimensions and sleep quality in postoperative orthopedic pati0ents, and to identify which aspects of pain most strongly affect sleep outcomes.*

Methodology: *A prospective observational study was conducted on 300 orthopedic surgical patients admitted to the Owaisi Group of Hospitals, Hyderabad, over six months. Pain was assessed using the Numerical Rating Scale (NRS) and SOCRATES mnemonic at baseline (0 hr), 48 hrs, and 15 days postoperatively. Sleep quality was evaluated on day 15 using the Pittsburgh Sleep Quality Index (PSQI). Data were analyzed using Spearman correlation and the Kruskal–Wallis test.*

Results and Discussion: *The majority were male (63.67%), aged 18–59 years, with falls (75%) and road traffic accidents (42.67%) as primary causes. Lower limb pain predominated. At baseline, severe pain (NRS ≥7) was universal; by day 15, mean pain score reduced to 2.67 ± 0.86. PSQI scores ranged from 3–10, with 95.3% scoring >5, indicating poor sleep quality. Pain and sleep scores showed a strong positive correlation ($\rho = 0.859$, $p < 0.001$). The Kruskal–Wallis test confirmed significant differences in sleep quality across pain categories ($\chi^2 = 221.057$, $p < 0.001$).*

Conclusion: *Higher postoperative pain is significantly associated with poorer sleep quality. Despite pain reduction over two weeks, sleep disturbances persisted in most patients, suggesting additional contributing factors. Multimodal pain control, sleep hygiene, and supportive interventions are recommended for better recovery.*

Keywords: *Postoperative pain, SOCRATES, sleep quality, orthopedic surgery, Pittsburgh Sleep Quality Index, Numerical Rating Scale, multimodal analgesia.*

INTRODUCTION

Postoperative pain is one of the most frequent and challenging issues following orthopedic surgery, often persisting beyond the immediate recovery period. Effective pain control is essential not only for comfort but also for optimizing rehabilitation, reducing hospital stays, and improving overall quality of life. Poorly managed pain can trigger a cycle of discomfort, reduced mobility, and secondary complications, among which sleep disturbance is particularly significant. Inadequate sleep can heighten pain perception, delay healing, and impair psychological well-being, while persistent pain disrupts normal sleep patterns, creating a bidirectional problem (Chou et al., 2016; Finan et al., 2013; Haack et al., 2020)[1,2,3].

The SOCRATES framework—an acronym for Site, Onset, Character, Radiation, Associations, Time course, Exacerbating/Relieving factors, and Severity—offers a systematic method to evaluate multiple aspects of a patient's pain (Kumar et al., 2023)[4]. Unlike unidimensional pain intensity scales, SOCRATES captures qualitative dimensions such as character, timing, and associated symptoms, enabling a more holistic understanding of the pain experience, particularly in orthopedic patients whose pain profiles often vary in type, onset, and aggravating factors (Kumar et al., 2023; Vissers et al., 2018)[4,5].

Sleep disturbances are common in orthopedic patients, with reported prevalence rates as high as 70–80% in the early postoperative phase (Maheshwari et al., 2022)[6]. Factors contributing to poor sleep include night-time pain, hospital environmental noise, restricted mobility, and psychological stress such as anxiety

about recovery (Maheshwari et al., 2022; Yue et al., 2021)[6,7]. Evidence shows that pain can alter sleep architecture, decreasing restorative deep and REM sleep, while insufficient or fragmented sleep can lower pain thresholds and reduce the effectiveness of analgesics (Finan et al., 2013; Haack et al., 2020; Tang et al., 2012)[2,3,8].

Preoperative sleep quality has also been linked to postoperative outcomes. Patients with disrupted sleep before surgery often experience greater postoperative pain, higher analgesic consumption, slower functional recovery, and, in some cases, persistent pain months after discharge (Yue et al., 2021; Chouchou et al., 2014)[7],[9]. Conversely, strategies to improve sleep—such as optimized analgesia, sleep hygiene interventions, or cognitive-behavioral therapy—have been associated with improved pain control and functional outcomes (Haack et al., 2020; Tang et al., 2012; Luyster et al., 2010).[3,8,10]

Despite these findings, few studies have examined how specific pain dimensions—beyond intensity—affect postoperative sleep quality. Identifying which aspects of pain, such as constant versus intermittent patterns, radiation, or activity-related exacerbation, most strongly influence sleep could help develop targeted interventions. This observational study aims to investigate the association between SOCRATES pain dimensions and sleep quality in orthopedic operative patients, providing evidence to guide integrated pain–sleep management approaches.

AIM AND OBJECTIVES

This study aims to understand the relation between pain and sleep in orthopedic patients. Pain will be assessed using the SOCRATES method, and sleep quality will be measured on the 15th day after surgery using the Pittsburgh Sleep Quality Index. The research will compare pain scores from the Numerical Rating Scale with sleep scores to see how they are associated. It will also find which component of the sleep scale is most related to poor sleep.

METHODOLOGY

This prospective observational study was conducted on postoperative orthopedic patients admitted to the inpatient department of the Owaisi Group of Hospitals, Hyderabad. The study enrolled a total of 300 patients over a period of six months. Approval for the study was obtained from the Institutional Ethics Committee, and written informed consent was collected from all participants prior to inclusion in the study.

Eligibility Criteria:

The studies included adult patients aged 18 years and above who underwent orthopedic surgery, were able to communicate effectively, provided written informed consent, and expressed willingness to participate in a follow-up assessment on the 15th postoperative day. Patients were excluded if they had a pre-existing diagnosed sleep disorder, were on long-term sedatives or psychiatric medications, had cognitive impairment or any condition preventing completion of the questionnaires, or were pregnant or lactating.

Data Collection:

Demographic and clinical information was obtained for each patient, including age, gender, presenting complaints, relevant past medical history, present illness, and personal history. Pain intensity was assessed using the Numerical Rating Scale (NRS) at multiple time points — immediately after surgery (0 hours), at 48 hours postoperatively, at discharge, and during follow-up at 15 days.

Pain characteristics were evaluated using the SOCRATES mnemonic, which examines the site, onset, character, radiation, associated symptoms, timing, exacerbating/relieving factors, and severity of pain. Details of the surgical procedure performed and medications administered during the hospital stay were recorded.

Sleep Quality Assessment:

At the 15-day follow-up, sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI). The relationship between pain parameters and sleep quality was analyzed, along with identification of the sleep scale components most strongly associated with poor sleep outcomes.

RESULTS

Demographics:

The study population comprised 300 orthopedic patients, with the majority falling within the 18–38 years age group (38.67%), followed by those aged 39–59 years (36.33%). Older adults aged 60–80 years accounted for 22%, while individuals aged 81 years and above represented only 3% of the sample. This indicates that the younger and middle-aged population formed the bulk of the study cohort, reflecting the active, working-age groups who are more prone to orthopedic injuries. Gender distribution showed a higher proportion of male patients (63.67%) compared to females (36.33%), suggesting that men may be more frequently exposed to occupational, outdoor, and high-risk physical activities contributing to injuries. Pain was the most common presenting complaint, reported by all 300 patients, while swelling was noted in 67.67% of cases, often accompanying the primary pain symptom.

Table 1: Demographic details

Demographic	**No. of Patients**
Age	
• 18–38 Years	116
• 39–59 Years	109
• 60–80 Years	66
• 81 & Above	9
Gender	
• Male	191
• Female	109
Chief Complaints	
• Pain	300
• Swelling	203
Past History	
• Diabetes Mellitus	101
• Hypertension	80
• Coronary Artery Disease	11
• Chronic Kidney Disease	4
• Gall Stone	4
• Hypothyroidism	6
• Epilepsy	8
• Osteoarthritis	5
Cause of Pain	
• Fall-Related	225
• RTA (Road Traffic Accidents)	128
• Trauma	54
• Twist Injuries	12
• Machine Injuries	6

Regarding comorbidities, diabetes mellitus was the most prevalent (33.67%), followed by hypertension (26.67%). Less frequent conditions included coronary artery disease (3.67%), chronic kidney disease and gallstones (each 1.33%), hypothyroidism (2%), epilepsy (2.67%), and osteoarthritis (1.67%). This profile suggests a considerable proportion of patients had chronic illnesses that could influence recovery and postoperative outcomes.

The cause of pain was predominantly fall-related injuries (75%), followed by road traffic accidents (42.67%), direct trauma (18%), twist injuries (4%), and machine-related injuries (2%). Falls being the leading cause may reflect a higher incidence in both the elderly (due to reduced balance and bone fragility) and younger adults engaged in physical or occupational activities.

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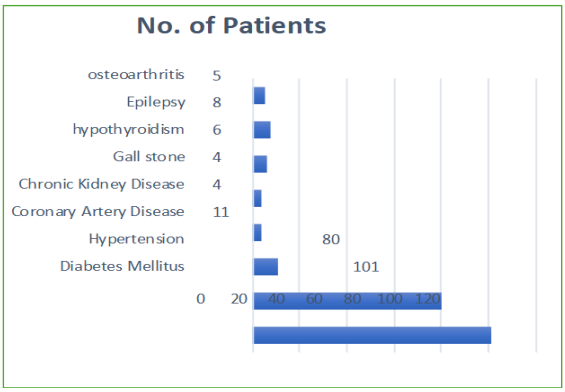

Fig. 1: Co-morbidity

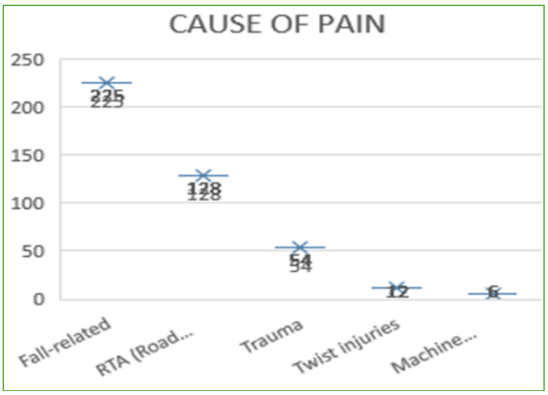

Fig. 2: Cause of Pain

Overall, the demographic profile highlights that orthopedic patients in this sample were largely younger to middle-aged males, most frequently presenting with pain due to falls, and a significant proportion had metabolic or cardiovascular comorbidities.

Assessment of SOCRATES Scale:

The SOCRATES analysis of pain patterns among the orthopedic patient provides a detailed understanding of pain presentation and its qualitative dimensions. Site of pain assessment revealed that the leg was the most frequently affected region (25% of patients), followed by the knee (20.33%) and hip (17%). Less common sites included the hand, thigh, ankle, and foot, each ranging between 6–7%, while pain in the shoulder, elbow, wrist, fingers, and face occurred less frequently, suggesting that lower limb injuries predominated in this cohort.

Regarding onset, pain developed suddenly in 55.33% of patients, while 44.67% experienced a gradual onset, possibly reflecting differences between acute traumatic injuries and chronic degenerative or overuse conditions. In terms of pain characteristics, throbbing pain was most common (32.33%), followed by aching (26.33%) and dull sensations (24%). Sharp, stabbing, and shooting pains were less frequent, while burning pain was rare (0.33%), suggesting a predominantly nociceptive pain pattern rather than neuropathic.

Pain radiation was reported by 45% of patients, indicating possible nerve involvement or referred pain in nearly half of the cases. Associated symptoms such as swelling, redness, or numbness were present in 28.67% of patients, while the majority (71.33%) had no associated features. Pain duration per episode was variable—36.67% experienced pain for 30–60 minutes, 32.67% for less than 30 minutes, 24.33% for 60–90 minutes, and 6% for longer than 90 minutes, reflecting differences in injury severity and activity-related exacerbations.

Table 2: SOCRATES scale

SOCRATES and No. of Patients			
Site		**Radiation**	
Leg	75	Yes	135
Knee	61	No	165
Hip	51	**Association**	
Hand	22	Yes	86
Thigh	21	No	214
Ankle	20	**Time Range**	
Foot	18	0–30 mins	98
Shoulder	11	30–60 mins	110
Elbow	11	60–90 mins	73
Wrist	10	90–120 mins	18
Finger	8		
Face	2	**Exacerbating**	
Onset		Yes	80
Gradual	134	No	220
Sudden	166		
Characteristics of Pain		**Severity (NRS at 0Hr)**	

Throbbing	97	0-6	0
Aching	79	7	77
Dull	72	8	109
Shooting	21	9	101
Sharp	20	10	13
Stabbing	19		
Burning	1		

Exacerbating factors were identified in 26.67% of cases, indicating that in some patient's pain was aggravated by movement, weight-bearing, or specific activities. The severity of pain at baseline (0-hour NRS) was predominantly high: 36.33% reported a score of 8, 33.67% scored 9, and 25.67% scored 7.

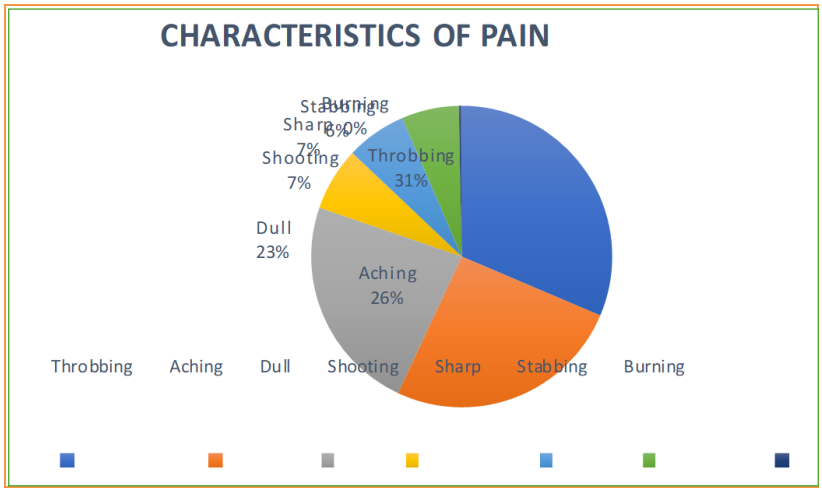

Fig. 3: Characteristics of Pain

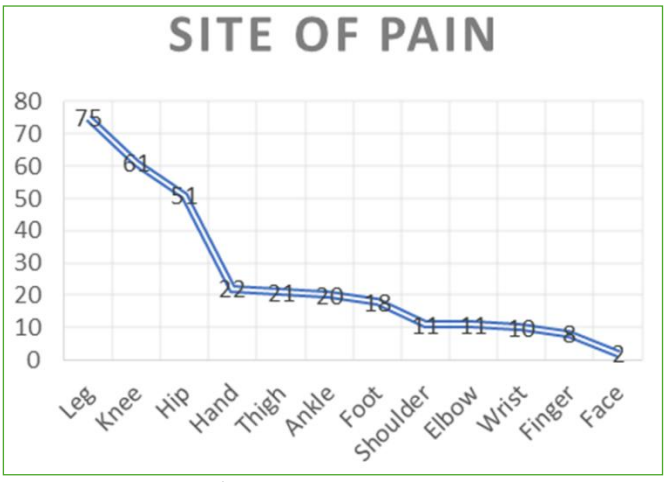

Fig. 4: Site of Pain

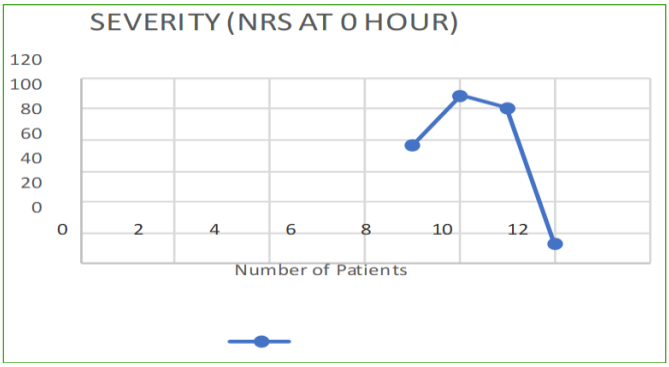

Fig. 5: Severity (NRS at 0hr)

Treatment:

The medication profile of the study group reflects a multimodal pharmacological approach aimed at infection prevention, pain control, symptom relief, and postoperative recovery. Antibiotics were widely prescribed, with Inj. Cefuroxime being the most common choice (58% of patients), followed by Inj. Ceftriaxone (44%), Inj. Metrogyl (39%), and Inj. Amikacin (35.33%). This pattern suggests a preference for broad-spectrum antibiotic coverage, likely to prevent surgical site infections and address mixed bacterial flora in trauma-related injuries. Proton pump inhibitors such as Inj. Pantoprazole were administered to 91.67% of patients, indicating a proactive approach to preventing stress-related gastric mucosal injury, particularly in patients receiving NSAIDs or multiple medications. Among anti-emetics, Inj. Ondem was used in 35.33% of cases, primarily to control nausea and vomiting associated with anesthesia/opioid use.

Table 3: Medication Prescribed

Class of Drug	Medication Prescribed	No. of Patients
Antibiotics	Inj. Amikacin	106
	Inj. Cefuroxime	174
	Inj. Ceftriaxone	132
	Inj. Metrogyl	117
PPI	Inj. Pantoprazole	275
Anti-Emetics	Inj. Ondem	106
Analgesics	Inj. Diclofenac	204
	Inj. Tramadol	115
	Inj. PCM	225
Supplements	T. Bio D3	273
	T.A To Z	196
	T. Limcee	235
Anti-Inflammatory	T. Trypsin Chymotrysin	197
	T. Enzictra DS	183
Anticoagulant	Inj. Enoxaparin 40mg	154
Antidepressant	T. Gabaneuron	68
	T. Nerve Plus	84

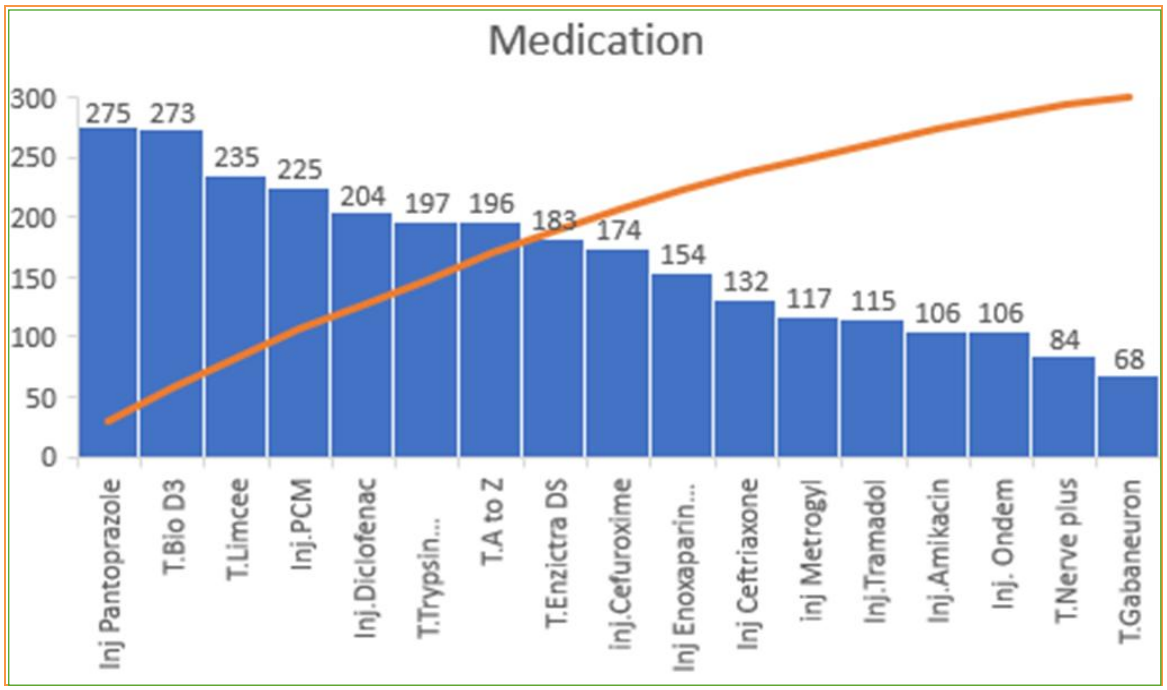

Fig. 6: Medication Prescribed

Analgesic prescriptions revealed a multimodal pain management strategy: Inj. PCM (75%), Inj. Diclofenac (68%), and Inj. Tramadol (38.33%) were frequently combined to balance effective pain relief while minimizing side effects of any single drug class.Nutritional supplements were also extensively used—T. Bio D3 (91%), T. Limcee (78.33%), and T. A to Z (65.33%)—to support bone healing, immune function, and overall recovery.For anti-inflammatory therapy, T. Trypsin Chymotrypsin (65.67%) and T. Enzictra DS (61%) were frequently prescribed, likely to reduce postoperative edema and improve tissue repair.

Anticoagulant prophylaxis with Inj. Enoxaparin 40 mg was given to 51.33% of patients, particularly those at higher risk of deep vein thrombosis due to reduced mobility after surgery. A smaller proportion of patients were prescribed adjuvant medications for neuropathic pain or mood stabilization, such as T. Nerve Plus (28%) and T. Gabaneuron (22.67%), reflecting individualized treatment for nerve-related pain or psychological distress. The pain score distribution over three times points—baseline (0 hours), 48 hours, and 15 days—demonstrates a clear trend of pain reduction following orthopedic management.

Pain Scores at different time interval:

At baseline (0 hours), pain scores were predominantly high: the largest proportions of patients recorded scores of 8 (36.33%), 9 (33.67%), and 7 (25.67%), indicating severe pain in most cases immediately after injury or surgery. Only a small fraction (4.33%) reported the maximum score of 10.

By 48 hours, there was a substantial shift toward moderate pain levels. The majority of patients scored 5 (49.33%), 4 (28%), and 6 (22%), reflecting effective initial pain control with analgesics and postoperative care. High-intensity scores (≥7) were almost completely absent at this stage. At 15 days, the pain profile shifted further toward mild levels. The most frequent scores were 2 (50.67%), 3 (36.67%), and 4 (10%), with only isolated cases reporting a score of 5 or higher. This suggests that most patients achieved significant pain relief by the second postoperative week.

Table 4: Pain Score at 0 hr., 48 hr., and 15th day

Pain Score (NRS)	0 hr.	48 hr.	15 days
1	0	0	0
2	0	0	152
3	0	0	110
4	0	84	30
5	0	148	6
6	0	66	2
7	77	2	0
8	109	0	0
9	101	0	0
10	13	0	0

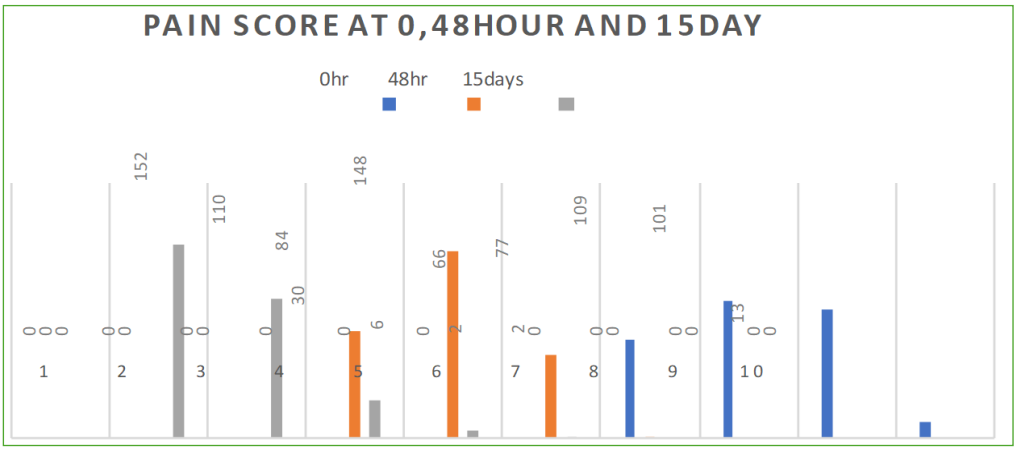

Fig. 7: Pain Score at 0 hr., 48 hr., and 15th day

Assessment of Sleep using Pittsburgh Sleep Quality Index (PSQI)

The Pittsburgh Sleep Quality Index (PSQI) global scores among postoperative orthopedic patients ranged from 3 to 10, with no patients recording scores ≤2 or >10. The modal score was 6 (n = 87; 29.8%), followed by scores of 7 (n = 69; 23.6%) and 5 (n = 67; 23.0%). Relatively better sleep quality (scores 3–4) was observed in only 46 patients (15.7%). A small proportion of patients recorded more severe sleep disturbances, with scores of 8–10 (n = 31; 10.6%). Given that a PSQI score >5 is indicative of poor sleep quality, 95.3% of patients in this study met the criteria for significant sleep disturbance. The clustering of scores between 5 and 8 reflects a predominance of moderate impairment rather than extreme sleep deprivation, although the absence of low scores suggests a near-universal impact on postoperative sleep.

Table 5: Global Sleep score (Pittsburgh Sleep quality Index)

Global Score	No. of patients	Global Score	No. of patients
1	0	11	0
2	0	12	0
3	5	13	0
4	41	14	0
5	67	15	0
6	87	16	0
7	69	17	0
8	27	18	0
9	3	19	0

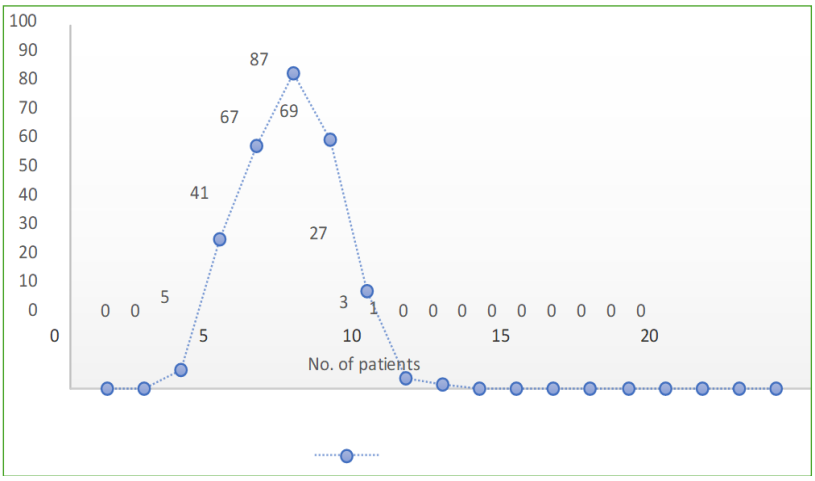

Fig. 8: Global Sleep score (Pittsburgh Sleep quality Index)

Correlation between sleep and pain at day 15:

Table 6: Association between pain (NRS) and Sleep (Pittsburgh Sleep Quality Index) at 15th day

Variable	Mean	SD	Median	Min.	Max.	Spearman ρ	p-value	Kruskal–Wallis χ^2
Pain Score (15th day)	2.67	0.86	3	2	6	0.859	<0.001	221.057
Global Sleep Score	5.74	1.72	6	3	10	—	—	—

The descriptive statistics for pain score at 15 days postoperatively and PSQI global sleep score, along with their correlation and non-parametric group comparison. The mean pain score was 2.67 ± 0.86 (median: 3; range: 2–6), while the mean global sleep score was 5.74 ± 1.72 (median: 6; range: 3–10).

The Kruskal–Wallis test yielded a chi-square value of 221.057 ($p < 0.001$), confirming a statistically significant difference in global sleep scores across the different pain score categories.

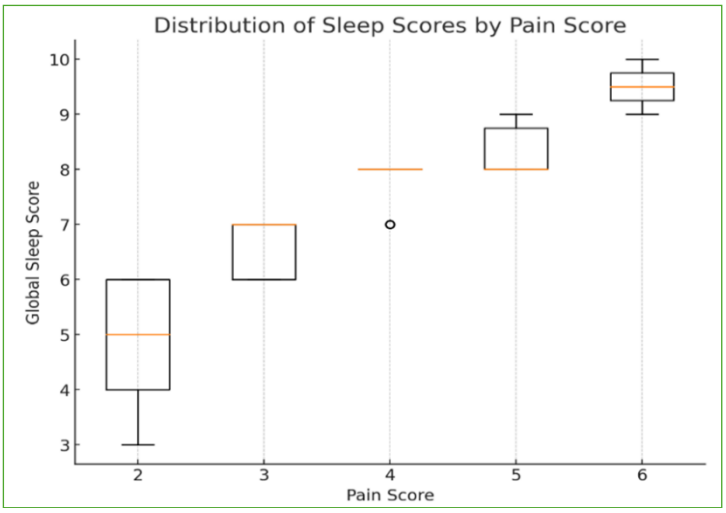

Fig. 9: Kruskal–Wallis test showing association between pain (NRS) and Sleep (Pittsburgh Sleep Quality Index) at 15th day

A Spearman correlation coefficient (ρ) of 0.859 ($p < 0.001$) was observed between pain score and global sleep score, indicating a strong positive correlation—patients with higher postoperative pain tended to have poorer sleep quality.

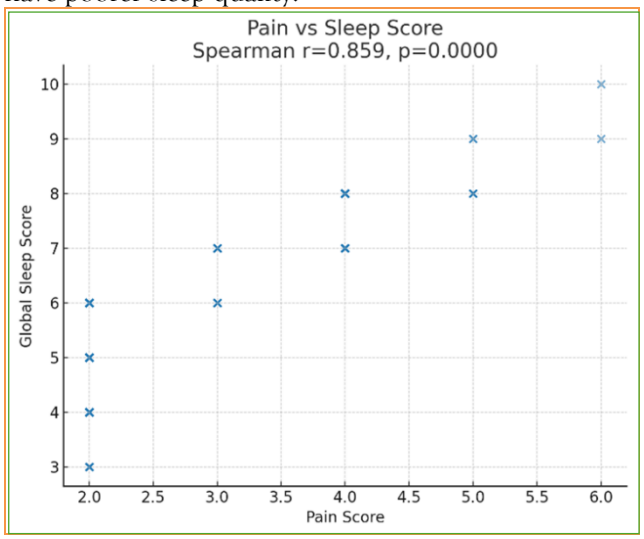

Fig. 10: Spearman correlation coefficient (ρ) showing association between pain (NRS) and Sleep (Pittsburgh Sleep Quality Index) at 15th day

DISCUSSION

The present study highlights the intricate relationship between postoperative pain and sleep quality in orthopedic patients, demonstrating that pain severity is a significant determinant of sleep disturbance. The high prevalence of poor sleep quality (95.3% with PSQI > 5) in our cohort is consistent with the established understanding that acute postoperative pain disrupts normal sleep pattern, leading to fragmented and non-restorative rest (Finan et al., 2013; Liu et al., 2021).[2,11] The strong positive correlation between pain scores and global sleep scores ($\rho = 0.859$, $p < 0.001$) underscores the interdependence of these variables, confirming that better pain control may be pivotal in improving sleep outcomes (Tang et al., 2007).[12]

Previous research by Begum et al. (2025)[13] on Total Pain Relief (TOTPAR) emphasized the importance of effective multimodal analgesia in achieving sustained pain reduction during the postoperative period. Their findings align with our observation that patients experienced substantial pain score reductions from baseline to 48 hours and further improvement by the 15th postoperative day. The use of combined analgesic regimens, including paracetamol, NSAIDs, and opioids, as reported in their study, was also evident in our patient population, indicating a clinical preference for multimodal strategies to maximize pain control while minimizing side effects.

Our results also resonate with the comparative study by Begum et al. (2022)[14], which evaluated NSAIDs combined with opioids versus NSAIDs combined with tricyclic antidepressants (TCAs) in postoperative pain management. That study demonstrated that incorporating adjuvant medications can improve patient comfort and potentially influence recovery trajectories, findings that parallel our observations regarding the use of gabapentinoids and nutritional supplements in the present cohort. While our study did not measure functional recovery directly, the integration of such adjunct therapies may have contributed to faster pain resolution and improved quality of life in some patients.

The predominance of lower limb pain, particularly in the leg and knee, reflects the common injury patterns in orthopedic trauma (Venkatesh et al., 2020),[15] consistent with global epidemiological data where high-energy injuries and falls are leading causes of such presentations. The male predominance (63.67%) and higher incidence in younger and middle-aged adults in our study could be attributed to occupational and lifestyle factors, as previously reported in orthopedic injury epidemiology (Chou et al., 2016).[1]

The temporal reduction in pain scores in our study—markedly from severe pain at baseline to predominantly mild pain at 15 days—parallels findings in similar orthopedic pain studies, where prompt surgical intervention and standardized analgesic protocols facilitated rapid pain control (Begum et al., 2025; Begum et al., 2022).[13] Importantly, despite effective pain reduction, a significant number of patients continued to report moderate sleep impairment, suggesting that non-pain factors such as hospital environment, psychological stress, and medication side effects may also contribute to postoperative sleep disturbances (Riemann et al., 2017).[16]

Our antibiotic prescribing trends, dominated by cefuroxime and ceftriaxone, align with standard surgical prophylaxis protocols aimed at preventing postoperative infections (Chou et al., 2016)[1]. The high rate of nutritional supplementation use, particularly vitamin C and vitamin D3, reflects emerging evidence on their potential roles in bone healing and immune function in orthopedic recovery. Anti-inflammatory enzyme preparations were also commonly prescribed, consistent with their known benefits in reducing postoperative edema and improving tissue repair (Aili et al., 2015).[17]

The implications of these findings are clinically relevant. Addressing postoperative sleep disturbances should be a priority alongside pain management, as both are interlinked and significantly influence recovery quality. Interventions such as optimizing analgesic timing, minimizing nocturnal disturbances, and incorporating non-pharmacological sleep aids could yield better patient outcomes (Chaput et al., 2018).[18]

CONCLUSION

This study found a strong link between pain after orthopedic surgery and poor sleep quality. Almost all patients had disturbed sleep in the early recovery period, especially those with higher pain scores. Pain was at its peak soon after surgery but reduced greatly over two weeks with a multimodal treatment approach. Even after pain improved, many patients still experienced sleep problems, suggesting that other factors such as stress, hospital environment, and medicines may affect rest. Most cases involved lower limb injuries, and a larger number of patients were younger or middle-aged men, possibly due to work and activity patterns. These results highlight the need for care plans that focus on both pain relief and better sleep. Combining medicines, rehabilitation, and supportive measures can help patients recover faster and improve their overall quality of life.

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