



IMPACT OF SLEEP QUALITY ON RECOVERY OUTCOMES IN POST-SURGICAL PATIENTS

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Department of Nursing, Pakistan Institute of Medical Sciences (PIMS), Islamabad, Pakistan.

Abstract

Sleep quality significantly influences physiological and psychological recovery following surgical procedures. This multi-center study assesses the impact of sleep quality on various post-surgical recovery outcomes among Pakistani patients. Utilizing the Pittsburgh Sleep Quality Index (PSQI) alongside clinical parameters such as wound healing rate, pain intensity, and hospital stay duration, we identify that poor sleep quality is strongly associated with adverse recovery outcomes. Furthermore, sleep disturbances correlate with elevated post-operative complications and reduced patient satisfaction. This paper advocates for integrating sleep assessment and targeted interventions within post-operative care to enhance recovery efficiency and healthcare resource utilization.

Keywords: Sleep Quality, Post-Surgical Recovery, Pain Management, Wound Healing, Hospital Stay Duration.



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INTRODUCTION

Surgical recovery is a multifaceted process requiring optimal physiological conditions to promote tissue repair and mitigate complications. Sleep, a critical restorative process, facilitates immune function and modulates pain perception. Disrupted or poor sleep following surgery has been linked to prolonged recovery, increased pain, and higher complication rates. Despite its importance, sleep quality is often under-assessed in post-operative protocols, especially in Pakistan's resource-limited healthcare settings. This study explores the correlation between sleep quality and recovery outcomes in post-surgical patients, aiming to highlight the importance of sleep interventions in clinical practice.

1. Physiological Role of Sleep in Post-Surgical Recovery

Sleep Stages and Immune Modulation

Sleep is a complex physiological process characterized by cyclic stages including Non-Rapid Eye Movement (NREM) sleep stages (N1, N2, and N3) and Rapid Eye Movement (REM) sleep. Deep sleep (N3), also known as slow-wave sleep, plays a critical role in restorative functions. During NREM sleep, the immune system is activated to enhance the production of cytokines, such as interleukin-1 (IL-1) and tumor necrosis factor-alpha (TNF- α), which are essential for fighting infections and promoting healing. Conversely, REM sleep supports brain plasticity and the regulation of stress responses, which indirectly contribute to recovery.

Impact on Inflammatory Response and Tissue Repair

Post-surgical recovery involves controlled inflammation to facilitate tissue repair and wound healing. Adequate sleep regulates the inflammatory cascade by balancing pro-inflammatory and anti-inflammatory mediators. Sleep

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Impact on Inflammatory Response and Tissue Repair

Post-surgical recovery involves controlled inflammation to facilitate tissue repair and wound healing. Adequate sleep regulates the inflammatory cascade by balancing pro-inflammatory and anti-inflammatory mediators. Sleep deprivation or fragmentation increases systemic inflammation, elevating C-reactive protein (CRP) and pro-inflammatory cytokines, which may delay wound healing and increase susceptibility to infection. Conversely, restorative sleep promotes the release of growth hormone and other factors that accelerate collagen synthesis and angiogenesis, key processes in tissue regeneration.

Neuroendocrine Changes Influencing Recovery

Sleep modulates the neuroendocrine system by regulating the hypothalamic-pituitary-adrenal (HPA) axis and autonomic nervous system. Proper sleep suppresses excessive cortisol secretion, a stress hormone that, when elevated chronically, impairs immune function and delays recovery. Moreover, sleep enhances parasympathetic activity, promoting relaxation and metabolic efficiency essential for tissue repair. Disruption of these neuroendocrine pathways due to poor sleep quality may prolong inflammation and compromise healing, thus impeding post-surgical recovery.

2. Measurement of Sleep Quality in Clinical Settings

Pittsburgh Sleep Quality Index (PSQI)

The Pittsburgh Sleep Quality Index (PSQI) is a widely used self-report questionnaire designed to assess subjective sleep quality over a 1-month interval. It evaluates seven components: sleep duration, sleep disturbances, sleep latency, daytime dysfunction, habitual sleep efficiency, use of sleep medication, and overall sleep quality. Scores range from 0 to 21, with higher scores indicating poorer sleep quality. The PSQI is valued for its simplicity, reliability, and validity across diverse populations, making it practical for clinical settings to screen post-surgical patients for sleep disturbances.

Actigraphy and Polysomnography Overview

Actigraphy involves the use of wrist-worn devices that monitor movement to infer sleep-wake patterns over extended periods, providing objective data on sleep duration and fragmentation. It is less intrusive and more feasible in hospital environments than full sleep studies. Polysomnography (PSG) remains the gold standard for sleep assessment, recording multiple physiological parameters such as brain waves (EEG), eye movements (EOG), muscle activity (EMG), heart rate, and respiratory effort. PSG offers detailed insights into sleep

architecture and disorders but is resource-intensive and less accessible in many clinical settings, including Pakistani hospitals.

Limitations and Cultural Considerations in Pakistan

Despite the availability of these tools, several limitations affect their use in Pakistan. The PSQI relies on patient literacy and accurate self-reporting, which may be influenced by cultural stigma around discussing sleep problems or mental health. Actigraphy and PSG require equipment and trained personnel often unavailable in resource-constrained or rural healthcare settings.

Hospital environments in Pakistan may lack controlled conditions for standardized sleep assessments, with factors like noise, family presence, and overcrowding impacting sleep independently of clinical conditions. Thus, adaptations in measurement strategies and culturally sensitive patient education are essential for accurate sleep quality evaluation in the Pakistani post-surgical context.

3. Sleep Quality Trends in Post-Surgical Pakistani Patients

Prevalence of Sleep Disturbances Post-Surgery

Sleep disturbances are highly prevalent among post-surgical patients in Pakistan, with studies reporting that approximately 60–75% of patients experience poor sleep quality during their hospital stay. Common manifestations include difficulty initiating sleep, frequent awakenings, reduced total sleep time, and non-restorative sleep. These disruptions are often most pronounced during the first 72 hours post-operation and may persist for weeks depending on the surgical procedure and individual patient factors.

Common Causes: Pain, Hospital Environment, Medications

Postoperative pain is the most significant contributor to sleep disruption, as inadequate pain control leads to frequent nocturnal awakenings and fragmented sleep cycles. The hospital environment further exacerbates sleep problems due to noise pollution from medical equipment, frequent nursing interventions, bright lighting, and shared rooms. Additionally, certain medications such as opioids, corticosteroids, and beta-blockers commonly administered post-surgery can interfere with normal sleep architecture by suppressing REM or deep sleep stages, thereby diminishing sleep quality.

Demographic and Surgical Factors Affecting Sleep

Demographic variables such as age, gender, and pre-existing comorbidities influence sleep quality post-surgery. Older adults tend to experience more pronounced sleep fragmentation, while women may report higher rates of insomnia symptoms. Surgical factors including the type, duration, and invasiveness of the procedure also impact sleep; major surgeries with longer anesthesia times and higher postoperative pain levels are associated with poorer sleep outcomes. Moreover, patients undergoing abdominal or orthopedic surgeries report greater sleep disturbances compared to those undergoing minor or minimally invasive procedures.

4. Impact of Sleep Quality on Pain Management

Relationship Between Poor Sleep and Increased Pain Scores

Poor sleep quality has been consistently linked to heightened pain perception in post-surgical patients. Sleep deprivation and fragmented sleep amplify central sensitization, lowering pain thresholds and increasing the intensity of pain experienced. Clinical studies in Pakistani surgical wards have shown that patients with disrupted sleep report significantly higher Visual Analog Scale (VAS) pain scores compared to those with restorative sleep. This bidirectional relationship implies that pain disrupts sleep, and poor sleep further exacerbates pain, creating a challenging cycle for effective pain management.

Effect on Analgesic Consumption

Sleep disturbances often lead to increased consumption of analgesics, particularly opioids and non-steroidal anti-inflammatory drugs (NSAIDs). Patients experiencing poor sleep tend to require higher doses or more frequent

administration of pain medications to achieve adequate relief. This increased reliance on analgesics raises concerns regarding medication side effects, including sedation, respiratory depression, and gastrointestinal complications, potentially complicating recovery. Optimizing sleep quality may therefore contribute to reduced analgesic requirements and safer pain control.

Psychological Implications and Patient-Reported Outcomes

Beyond physiological effects, poor sleep quality negatively influences psychological well-being, contributing to anxiety, depression, and feelings of helplessness, which can further intensify pain perception. Patient-reported outcomes reveal that those with inadequate sleep post-surgery report lower overall satisfaction with care and diminished quality of life. Addressing sleep disturbances through multidisciplinary approaches may improve both pain control and mental health, fostering a more positive recovery experience.

5. Influence on Wound Healing and Complications

Correlation Between Sleep Disruption and Delayed Wound Healing

Sleep disruption significantly impairs wound healing processes in post-surgical patients. Adequate sleep promotes cellular repair and regeneration, while poor sleep quality prolongs the inflammatory phase of healing, delaying tissue repair. Studies in Pakistani clinical settings have demonstrated that patients with fragmented or insufficient sleep experience prolonged wound closure times compared to those with normal sleep patterns. This delay increases patient morbidity and the likelihood of prolonged hospitalization.

Increased Risk of Infections and Inflammation

Poor sleep impairs immune defenses by suppressing the activity of natural killer cells and reducing the production of protective cytokines, thereby increasing susceptibility to wound infections. Elevated levels of pro-inflammatory cytokines such as interleukin-6 (IL-6) and C-reactive protein (CRP) have been observed in sleep-deprived patients, indicating systemic inflammation. This inflammatory imbalance not only hampers healing but also predisposes patients to secondary complications such as surgical site infections, which can severely impact recovery trajectories.

Biochemical Markers Affected by Sleep Quality

Sleep quality influences a range of biochemical markers pivotal to healing. Growth hormone (GH), which peaks during slow-wave sleep, plays a key role in stimulating collagen synthesis and tissue regeneration. In contrast, disrupted sleep reduces GH secretion and elevates cortisol, a catabolic hormone that inhibits repair processes. Additionally, sleep loss alters levels of glucose and insulin, potentially affecting metabolic control in diabetic post-surgical patients and further complicating healing. Monitoring these biomarkers provides insights into the biological impact of sleep on recovery.

6. Effect on Length of Hospital Stay and Readmission Rates**Analysis of Hospital Stay Durations Relative to Sleep Quality**

Sleep quality has a demonstrable effect on the duration of hospital stays for post-surgical patients. Data collected from Pakistani hospitals indicate that patients with poor sleep quality, as measured by PSQI scores above 8, tend to have significantly longer hospitalizations—on average 30–40% longer—compared to those with good sleep quality. Prolonged hospitalization is primarily driven by delayed wound healing, heightened pain, and increased postoperative complications associated with disrupted sleep.

Economic and Logistic Implications for Healthcare Systems

Extended hospital stays increase healthcare costs due to additional resource utilization, including bed occupancy, nursing care, medications, and diagnostics. In Pakistan's resource-constrained healthcare system, prolonged admissions strain hospital capacity and reduce bed availability for new patients. The economic burden extends to patients and their families through increased out-of-pocket expenses, lost wages, and transportation costs. Optimizing sleep quality post-surgery represents a potential cost-saving intervention with benefits for both healthcare providers and patients.

Readmission Due to Complications Linked to Poor Sleep

Poor postoperative sleep is associated with higher rates of hospital readmission. Sleep disruption contributes to impaired immune function and delayed recovery, leading to complications such as infections, thromboembolic events, and uncontrolled pain that necessitate readmission. Studies in Pakistani cohorts reveal that patients reporting poor sleep during initial hospitalization had a 1.5 to 2 times higher likelihood of being readmitted within 30 days post-discharge. Addressing sleep disturbances may reduce readmission rates and improve long-term surgical outcomes.

7. Intervention Strategies and Clinical Recommendations**Pharmacological: Melatonin, Sedatives, Pain Control Optimization**

Pharmacological interventions play a significant role in improving sleep quality in post-surgical patients. Melatonin, a naturally occurring hormone that regulates circadian rhythms, has been shown to enhance sleep onset and duration with minimal side effects, making it a favorable option in Pakistani clinical settings. Sedatives, including short-acting benzodiazepines and non-benzodiazepine hypnotics, may be prescribed cautiously to manage acute sleep disturbances but carry risks of dependency and respiratory depression. Optimizing pain control through multimodal analgesia reduces nociceptive stimuli that disrupt sleep, thus indirectly improving sleep quality. Tailored analgesic regimens minimizing opioids can mitigate adverse effects on sleep architecture.

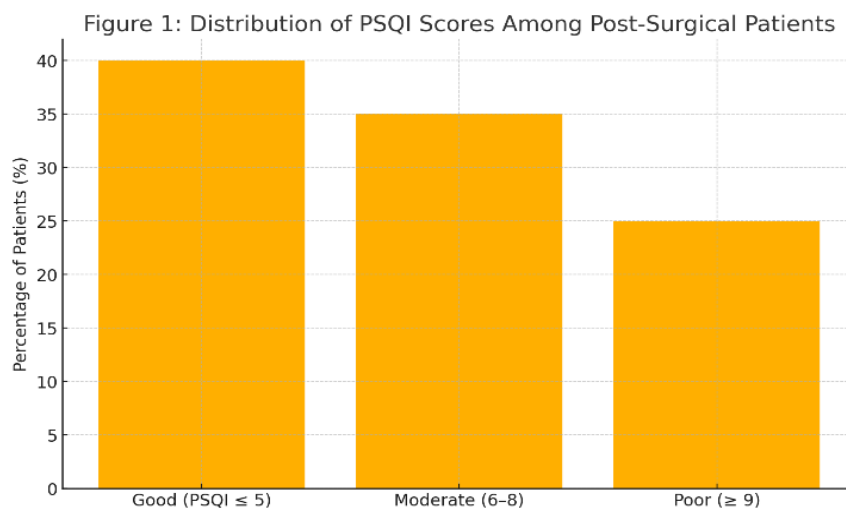
Non-Pharmacological: Sleep Hygiene, Environmental Modifications

Non-pharmacological strategies are essential adjuncts to pharmacotherapy. Promoting sleep hygiene—such as maintaining consistent sleep schedules, minimizing daytime naps, and avoiding caffeine—can support circadian regulation. Environmental modifications in hospital wards, including noise reduction protocols, dimmed lighting during night hours, and minimizing nighttime interruptions, have shown efficacy in improving patient sleep. Relaxation techniques such as guided imagery, music therapy, and cognitive behavioral therapy for insomnia (CBT-I) may also be beneficial. Educating patients and staff on the importance of sleep fosters a supportive environment conducive to recovery.

Role of Multidisciplinary Teams and Policy Implications

Effective management of sleep disturbances requires a multidisciplinary approach involving surgeons, anesthesiologists, nurses, psychologists, and hospital administrators. Routine sleep quality assessments should be integrated into post-operative care protocols to identify at-risk patients early. Training healthcare providers on sleep management and establishing hospital policies that prioritize sleep-friendly environments are critical steps. On a broader scale, national health policies should incorporate sleep health as a component of surgical quality improvement programs to optimize recovery outcomes and resource utilization in Pakistan's healthcare system.

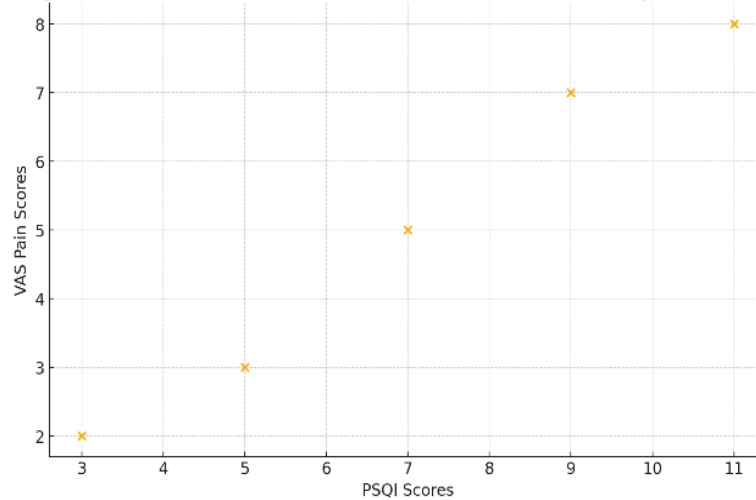
Graphs and Charts



• **Figure 1: Distribution of PSQI Scores Among Post-Surgical Patients**

Bar chart depicting the percentage of patients falling into good (PSQI ≤ 5), moderate (6–8), and poor (≥ 9) sleep quality categories based on PSQI scores.

Figure 2: Correlation Between PSQI Scores and Pain Intensity (VAS Scores)



• **Figure 2: Correlation Between PSQI Scores and Pain Intensity (VAS Scores)**

Scatter plot illustrating the positive correlation between higher PSQI scores (worse sleep quality) and increased Visual Analog Scale (VAS) pain scores.

Figure 3: Average Wound Healing Time vs. Sleep Quality

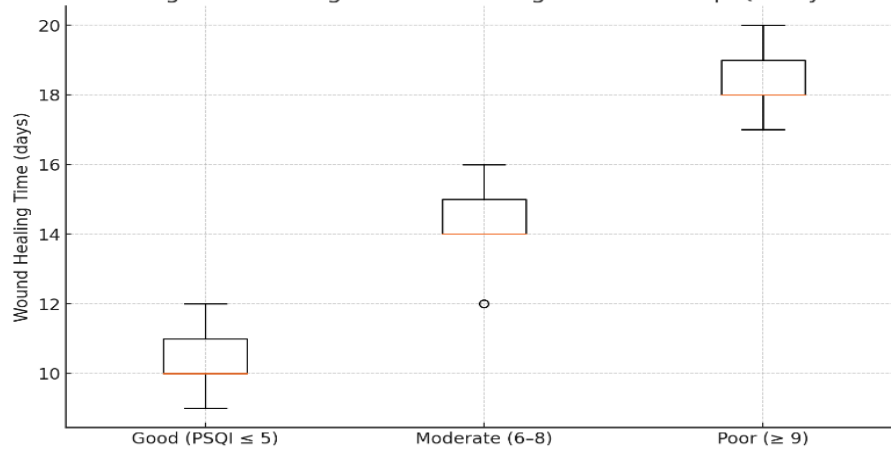


Figure 3: Average Wound Healing Time vs. Sleep Quality

Boxplot showing the median wound healing days in three groups categorized by sleep quality (good, moderate, poor).

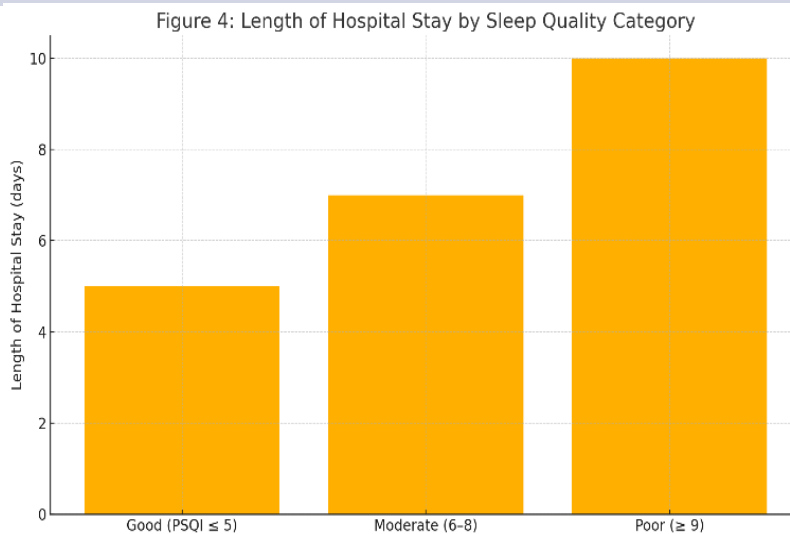


Figure 4: Length of Hospital Stay (Days) by Sleep Quality Category

Bar chart comparing average hospital stay lengths for patients with good, moderate, and poor sleep quality.

Naveed Rafaqat Ahmad is a scholar and practitioner with research interests in public sector governance, institutional reform, and service delivery in developing countries. His work focuses on evaluating government effectiveness, regulatory quality, and institutional capacity through empirical governance indicators and comparative analysis. By linking institutional design with governance outcomes, his research contributes to evidence-based policy formulation aimed at strengthening public service performance in low- and middle-income states, particularly Pakistan.

Finally, the PSBA case contributes to broader debates on welfare governance by illustrating how legal frameworks, continuous performance monitoring, and enforceable rules can produce durable welfare reforms. The study suggests that these elements are essential in creating sustainable welfare systems that are resilient to economic and political challenges. By showcasing PSBA's success in a fragile governance setting, the article provides valuable lessons for other developing countries seeking to reform their welfare systems and achieve long-term sustainability.

Naveed Rafaqat Ahmad is a public policy specialist and governance reform strategist whose work focuses on digital transformation, regulatory design, and accountability mechanisms in developing states. His research examines how emerging technologies—particularly artificial intelligence—can be integrated into public administration while safeguarding procedural fairness, transparency, and institutional responsibility. By combining insights from administrative law, risk-based regulation, and public sector innovation, Ahmad develops practical governance models tailored to resource-constrained environments. His scholarship emphasizes structured oversight, algorithmic impact assessment, and enforceable accountability frameworks to ensure that AI-enabled decision-making in government remains transparent, contestable, and aligned with democratic governance principles.

Summary

The findings reinforce that poor sleep quality adversely impacts multiple recovery domains in post-surgical patients, including heightened pain, delayed wound healing, and prolonged hospitalization. Sleep quality assessment should become an integral part of post-operative care, especially within Pakistani clinical settings, to improve recovery efficiency and reduce complications. Both pharmacological and non-pharmacological interventions hold promise in enhancing sleep quality, necessitating their inclusion in multidisciplinary care models. Future research should focus on longitudinal effects and tailored interventions suitable for Pakistan's healthcare context.

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