fortune Journals

Research Article

JOURNAL OF SPINE RESEARCH AND SURGERY

ISSN: 2687-8046

Impact of Sleep Disorders and Sleep Quality on Psychological Well-Being and Quality of Life in Patients with Traumatic Spinal Cord Injury

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Abstract

Background: Many people with traumatic spinal cord injury (TSCI) struggle with bad sleep, which is relationship to a reduced quality of life (QoL).

Objective: The study aims to investigate how sleep disorders and the sleep quality influence the psychological well-being and QoL of individuals who have experienced a TSCI.

Methods: This is a cross-sectional quantitivae study of TSCI patients patients admitted to Wuhan Hospital, Rehabilitation department, we used Pittsburgh Short form-12, and Sleep Quality Index (PSQI) to assess QoL, and quality of sleep, respectively. Moreover, was used Self-Rating Anxiety, and Depression Scale (SAS, and SDS)

To assess anxiety, and depression among of TSCI patients.

Results: The Physical Component Summary (PCS-12) score was 16.43 (SD = 1.87) and the Mental Component Summary (MCS-12) score was 23.05 (SD = 1.09). Correlation analysis indicated that the PCS-12 had a negligible correlation with the PSQI (r = 0.04, p = 0.64) and a moderate correlation with SAS (r = 0.34, p = 0.87), while its correlation with SDS was minimal (r = 0.12). In contrast, the MCS-12 showed a significant positive correlation with the PSQI (r = 0.45, p = 0.03) but weak correlations with the SDS (r = 0.24, p = 0.85) and SAS (r = 0.12, p = 0.53). This suggests complex interactions among injury characteristics, gender, and sleep disorders in relation to quality of life measures.

Conclusion: Our outcomes emphasize important role that sleep disorders. Furthermore, sleep quality play in the psychological well-being of individuals with TSCI.

Keywords: Sleep Disorders; Traumatic Spinal Cord Injury; Sleep Quality; Quality of Life.

Introduction

Sleep disorders are common prevalent among people with traumatic spinal cord injury (TSCI) compared to the population and associated with diminished engagement and quality of life (QoL) [1]. In contrast to healthy individuals, those with TSCI report greater subjective sleep issues, including challenges in initiating sleep and frequent awakenings [2, 3]. Several factors may negatively affect sleep following TSCI, including extremely elevated level of sleep-disordered breathing (SDB), especially in individuals with high level thoracic and cervical traumas [4], frequent occurrences of dysfunction leg movements when both wakefulness and sleep, and overall poor sleep quality [5].

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Citation: Ruba Altahla, Jamal Alshorman, Maria karaminasian, Somayeh Sadeghi, Mohammed Alnaggar. Impact of Sleep Disorders and Sleep Quality on Psychological Well-Being and Quality of Life in Patients with Traumatic Spinal Cord Injury. Journal of Spine Research and Surgery. 7 (2025): 26-32.

Received: March 17, 2025
Accepted: March 24, 2025
Published: March 26, 2025

Altahla R, et al., J Spine Res Surg 2025
DOI:10.26502/fjsrs0084

In previous studies, it has been found that individuals with tetraplegia report sleep difficulties and a lower QoL compared to their able-bodied peers. Additionally, QoL is associated with factors (severity of the injury, age, and the presence of sleep symptoms) [6].

The fundamental reasons for sleep issues in TSCI remain insufficiently understood and appear to be linked to SDB or the influence of melatonin on disrupting the rhythm [7,8]. Sleep disruptions frequently signify insufficient rest during the night, leading to heightened daytime fatigue. This affects mental functioning and results in impaired mental function in TSCI people (3), conditions, possibly worsening the health of individuals with TSCI [9]. Nonetheless, around forty percent of TSCI have been risk of developing psychological disorders like depression, anxiety. Consequently, inadequate sleep quality disrupts the capacity of individuals with SCI to engage in meaningful activities and responsibilities, potentially resulting in a diminished QoL [10]. This interplay between sleep disorders and QoL becomes a critical area of study.

Moreover in Carlozzi NE.,etal study found multilevel types revealed that daily fluctuations in sleep significantly influenced next-day of QoL ratings. Quality of sleep correlated with other sleep-related measures, such as sleep disturbance and fatigue, but not with other QoL aspects. Overall, quality of sleep consistently affected fatigue and cognition throughout the day, although this association diminished over time [11].

The well-being and QoL of individuals with TSCI can be greatly influenced by sleep disorders. Inadequate sleep affects not only physical health but also emotional stability and cognitive abilities, resulting in difficulties with daily tasks and overall life satisfaction. Tackling sleep problems is essential for enhancing both well-being and quality of life in this group.

This research aims to explore the effects of sleep disorders and sleep quality on the well-being and QoL of TSCI people. By understanding these relationships, we can better inform clinical practices and develop targeted interventions that enhance the health outcomes and overall QoL for people have this condition.

Methods

Participants

TSCI in this cross-sectional quantitive survey were included specific criteria, which required a agreed diagnosis of TSCI and admission to the Wuhan Hospital (rehabilitation department) between July and December 2024. Initially, data were collected from 242 TSCI patients through purposive sampling. After excluding 28 patients 10 who were under 18, 5 who had cognitive issues, and 4 who did not complete the questionnaire additional exclusions were made for TSCI patients who declined to participate or had missing required data.

Data collection

Prior to completing the questionnaire, participants received a brief explanation of the study's purpose, the methdology involved, and the way of collected data was used. They were asked to reply all questions before submitting the questionnaire. Involvement was elective and based on personal choice, with no monetary compensation for participation. Demographic data, details about the injury, and information on sleep disorders were gathered from TSCI patients' records and other methods, in accordance with the principles of the Helsinki Declaration.

Survey questionnaire

QoL, sleep quality, anxiety, depression levels was collected. Furthermore, TSCI people completed a demographic data. The SCI is categorized based on the nature of the injury and the American Spinal Injury Association (ASIA) Impairment Scale (AIS), which divides TSCI into complete and incomplete classifications [12]. Rather, the researchers utilized ASIA grades to evaluate and establish the severity and extent of the injury. Furthermore, SDB, circadian rhythm sleep-wake disorders (CRSWD), data on insomnia and periodic leg movements during sleep were gathered from patient files.

Quality of life, Well-being

QoL was measured using the Short Form version 12 [13], which generates for both physical and mental, with normative scores set at 50 [14]. The SF-12 is commonly used in clinical settings related to TSCI.

Quality of sleep

Quality of sleep, the variable, was assessed by the Pittsburgh Sleep Quality Index, which has a total score between 0 to 21. This validated patient-reported of 19 items and demonstrates high ICC (McDonald's omega = 0.83) [15]. Participants reported on their sleep over the past month, with better PSQI scores indicating poorer quality; specifically, range above 5 are considered indicative of 'poor sleep quality.

Anxiety and depression scales

The Self-Rating Anxiety/Depression Scale was peformed to assess the level of anxiety and depression [16, 17]. This scale consists of 20 items, with participants rating on a 4-point. The raw score by 1.25 to obtain a standardized score, which ranges (25 -100), where higher value indicate greater severity of anxiety or depression. For this survey, a standard value (50/53) was used as the cutoff to determine the significance of SAS/SDS [18].

Data analysis

Data analysis was conducted using IBM SPSS software

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DOI:10.26502/fjsrs0084

version 26. Descriptive analyses were carried out for clinico-demographic information, SF-12 scores, PSQI scores, and self-rating scales for depression and anxiety. Categorical variables were reported as frequencies and percentages, while continuous variables were represented as mean ± standard deviation.

To evaluate the relationships between SF-12 scores and PSQI, as well as the self-rating scales for depression and anxiety, Spearman's rho correlation coefficient was employed. Furthermore, multiple linear regressions were utilized to identify predictors of QoL based on clinico-demographic factors among TSCI patients, with a significance threshold set at a p-value of 0.05.

Results

Demographic data of TSCI

Our study included individuals with TSCI characterized by varying injury levels: T7-T12 (36.09%), C1-C4 (29.26%), and C5-C8 (20.97%). Most injuries were classified as AIS B (37.56%) and paraplegia (64.39%). Road traffic accidents (RTAs) (34.63%) were the most common cause of injury, with an average duration since injury of 11.2 months.

The majority of injuries were incomplete (79.02%), and the population of male (83.9%), with a mean 36.8 old years. Most of TSCI (70.24%) were married. Sleep disorders were prevalent, with 68.78% reporting sleep-disordered breathing and 60.97% experiencing insomnia (Table 1).

Table1: Demographic characteristics of TSCI (n=205)

Characteristic	Category	N (%)/ Mean±SD
Level of injury	C1-C4	60 (29.26%)
	C5-C8	43 (20.97%)
	T1-T6	21 (10.24%)
	T7-T12	74 (36.09%)
	Lumbar or sacral	9 (4.39%)
Severity of injury AIS	A	67 (32.68%)
	B	77 (37.56%)
	C	41 (20%)
	D	20 (9.75%)
Paralysis type	Paraplegia	132 (64.39%)
	Tetraplegia	73(35.6%)
MOI	RTAs	71(34.63%)
	Falls (high/low)	58 (28.29%)
	Work-related injuries	40 (19.51%)
	Sports-related injuries	14 (6.82%)
	Other #	22 (10.73%)
Duration since the injury (months)		11.2(5.3)
State of injury	Complete	43 (20.97%)
	Incomplete	162 (79.02%)
Gender	Male	172 (83.9%)
	Female	33(16.09 %)
Age (years)		36.8 ± 9.9
Marital status	Married	144(70.24%)
	Un married	61(29.75%)
SDB	No	64(31.21%)
	Yes	141(68.78%)
CRSWD	No	88(42.92%)
	Yes	133(64.87%)
Insomnia	No	80(39.02%)
	Yes	125(60.97%)
Periodic leg movements	No	89(43.41%)
	Yes	116(56.58%)

TSCI: Traumatic Spinal Cord Injury; ASIA: American Spinal Injury Association scale; MOI: Mechansim of injury; RTAs: Road traffic accidents; SDB: Sleep-disordered breathing; CRSWD: circadian rhythm sleep-wake disorders; # included machinery-injury and violence injury.

Descrbtive of SF-12, PSQI, SDS, and SAS

The prevalence estimates for mild depression were 23.8% to 21.5% with anxiety, while 74.3% was with normal anxiety comparison to 67.5% of depression (Fig.1).

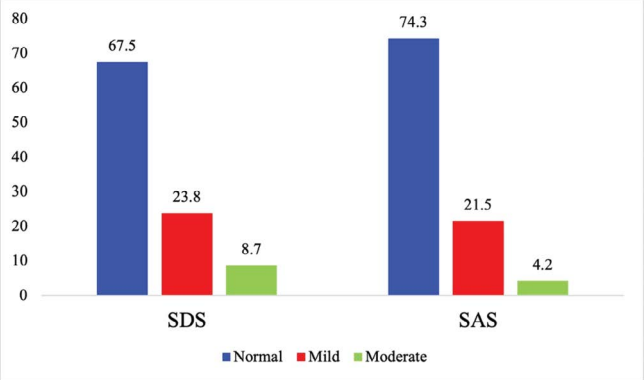

Figure1: Precentage of Self-Rating Depression Scale (SDS), and Self-Rating Anxiety Scale (SAS)

The findings indicate participants had a mean PCS-12 score of 16.43 (SD=1.87) and MCS-12 score of 23.05 (SD=1.09). Sleep quality assessments revealed a subjective sleep quality mean of 2.05 (SD=0.9), sleep latency of 1.74 (SD=0.7), sleep duration of 2.32 (SD=0.5), sleep efficiency of 2.12 (SD=0.6), sleep disturbances at 1.87 (SD=0.7), use of sleeping medication at 2.57 (SD=0.8), and daytime dysfunction at 1.75 (SD=0.6). Additionally, the Self-Rating Depression Scale (SDS) had a mean score of 54.05 (SD=6.82), while the Self-Rating Anxiety Scale (SAS) had a mean of 52.45 (SD=3.60) (Table 2).

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DOI:10.26502/fjsrs0084

Table 2: Descrbtive of SF-12, PSQI, SDS, and SAS scores among of TSCI

Scale	Subscale	N (%)/ Mean±SD
SF-12	PCS-12	16.43±1.87
	MCS-12	23.05±1.09
PSQI	Subjective sleep quality	2.05±0.9
	Sleep latency	1.74±0.7
	Sleep duration	2.32±0.5
	Sleep efficiency	2.12±0.6
	Sleep disturbances	1.87±0.7
	Use of sleeping medication	2.57±0.8
	Daytime dysfunction	1.75±0.6
SDS		54.05 ± 6.82
SAS		52.45 ± 3.60

The correlation analysis of QoL and sleep quality

The correlation analysis revealed that the PCS-12 had a negligible association with the PSQI ($r = 0.04$, $p = 0.64$) and a moderate correlation with the SAS ($r = 0.34$, $p = 0.87$), while the connection with the SDS was minimal ($r = 0.12$), the MCS-12 displayed a significant positive correlation with the PSQI ($r = 0.45$, $p = 0.03$). In contrast, it exhibited weak correlations with both the SDS ($r = 0.24$, $p = 0.85$) and SAS ($r = 0.12$, $p = 0.53$). These results indicate differing relationships between QoL indicators and mental measures (Table 3).

Table 3: Correlations between SF-12, SDS/ SAS and PSQI among of TSCI patients

SF-12	Spearman's rho correlation coefficient	SDS	SAS	PSQI
PCS-12	P	0.64	0.87	0.04
	r	0.12	0.34	0.21
MCS-12	P	0.85	0.53	0.03
	r	0.24	0.12	0.45

SF-12: Short-Form-12; PCS-12: Physical Component Summary of Short-Form-12; MCS-12: Mental Component Summary of Short-Form-12; PSQI, Pittsburgh Sleep Quality Index; SDS, Self-Rating Depression Scale; SAS, Self-Rating Anxiety Scale.

Multiple regression analyses of QoL

The analysis revealed that the level of injury significantly impacted the PCS-12 ($\beta = 2.32$, $p = 0.031$) and the overall SF-12 score ($\beta = 12.37$, $p < 0.001$). Severity of injury negatively affected PCS-12 ($\beta = -4.26$, $p < 0.001$) but had no significant effect on the MCS-12. Gender positively influenced PCS-12 ($\beta = 3.19$, $p = 0.021$) with a borderline significant negative effect on SF-12 ($\beta = -2.17$, $p = 0.05$). SDB negatively impacted PCS-12 ($\beta = -5.42$, $p = 0.035$) and positively affected SF-12 ($\beta = 3.12$, $p = 0.017$). Additionally, insomnia had a significant negative effect on PCS-12 ($\beta = -4.25$, $p = 0.024$) and a positive influence on SF-12 ($\beta = 1.68$, $p = 0.039$). Periodic leg movements negatively affected both PCS-12 ($\beta = -6.14$, $p = 0.031$) and SF-12 ($\beta = -9.74$, $p = 0.024$). Overall, these findings highlight the complex relationships between injury characteristics, gender, and sleep disorders on health-related quality of life measures (Table 4).

SF-12: Short-Form-12; PCS-12: Physical Component Summary of Short-Form-12; MCS-12: Mental Component TSCI: Traumatic Spinal Cord Injury; ASIA: American Spinal Injury Association scale; MOI: Mechansim of injury; Summary of Short-Form-12; PSQI: Pittsburgh Sleep Quality Index; SDB: Sleep-disordered breathing; CRSWD: circadian rhythm sleep-wake disorders ;bold: significant value.

Table 4: Predictors of QoL using multiple regression analyses among TSCI

Characteristics	PCS-12		MCS-12		Total SF-12	
	β	p-value	β	p-value	β	p-value
Level of injury	2.32	**0. 031**	0.585	0.467	12.37	**<0.001**
Severity of injury AIS	-4.26	**<0.001**	-3.51	0.677	0.18	**0.039**
Paralysis type	5.17	**0.044**	3.88	0.233	1.28	0.486
State of injury	2.23	0.554	4.01	0.557	3.47	0.525
MOI	3.43	1.201	3.873	0.673	12.92	0.381
Duration since the injury (months)	2.31	0.783	3.763	0.987	3.45	0.392
Gender	3.19	**0.021**	2.3	0.499	-2.17	**0.05**
Age (years)	2.45	0.527	-1.29	0.598	-12.14	0.346
Marital status	4.92	0.524	-3.11	0.476	0.87	0.886
SDB	-5.42	**0.035**	-2.31	0.468	3.12	**0. 017**
CRSWD	6.42	**0.024**	-2.84	0.463	10.65	**0.05**
Insomnia	-4.25	**0.024**	1.83	0.465	1.68	**0.039**
Periodic leg movements	-6.14	**0.031**	5.22	0.387	-9.74	**0.024**

SF-12: Short-Form-12; PCS-12: Physical Component Summary of Short-Form-12; MCS-12: Mental Component TSCI: Traumatic Spinal Cord Injury; ASIA: American Spinal Injury Association scale; MOI: Mechansim of injury; Summary of Short-Form-12; PSQI: Pittsburgh Sleep Quality Index; SDB: Sleep-disordered breathing; CRSWD: circadian rhythm sleep-wake disorders ;bold: significant value.

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DOI:10.26502/fjsrs0084

Discussion

This study evaluated the impact of sleep disorders and sleep quality on the psychological well-being and QoL of patients with TSCI. There were high prevalence of sleep issues in the TSCI people, understanding their impact is crucial, as poor sleep can exacerbate physical and psychological challenges. By exploring the association between sleep quality and QoL, this study illustrates the urgency for collective care solutions that encompass both sleep and rehabilitation, contributing to improved outcomes for TSCI patients.

This study highlights key demographic and clinical characteristics of individuals with TSCI. The prevalence of thoracic injuries (T7-T12 at 36.09%) and the high rate of paraplegia (64.39%) significantly impact mobility and independence. Most injuries are classified as AIS B (37.56%), reflecting advancements in emergency care [19].

RTAs are the leading cause of injury (34.63%), emphasizing the need for targeted prevention strategies [20]. The predominantly male population (83.9%) with a mean of 36.8 old years aligns with existing literature on higher TSCI incidence in younger males [21, 22, 23]. These findings underscore the complex relationship between injury characteristics and demographics in TSCI [19].

The prevalence of sleep disorders, with 68.78% reporting sleep-disordered breathing and 60.97% experiencing insomnia, is particularly concerning. Sleep disturbances are known to exacerbate both physical and mental health issues in individuals with TSCI, leading to poorer QoL [24]. Previous studies have documented that sleep disorders can significantly affect recovery and rehabilitation outcomes, reinforcing the need for comprehensive assessments and interventions targeting sleep health in this population [24, 25].

The study reveals significant impairments in QoL among participants with TSCI, evidenced by low mean scores of 16.43 (PCS-12) and 23.05 (MCS-12). Sleep quality assessments indicate poor subjective sleep quality (mean = 2.05), prolonged sleep latency (mean = 1.74), and alarmingly low sleep duration (mean = 2.32 hours), alongside high use of sleeping medication (mean = 2.57). Additionally, mental health indicators show elevated depression (SDS mean = 54.05) and anxiety (SAS mean = 52.45) levels, underscoring the interconnectedness of poor sleep and mental health challenges in this population. These outcomes highlight the urgent need for integrated targeting sleep quality and mental well-being to enhance overall health outcomes for individuals with TSCI.

The findings from this study reveal concerning levels of physical and mental health among participants with TSCI, with PCS-12 score of 16.43 (SD=1.87) and MCS-12 score of 23.05 (SD=1.09, indicating significantly impaired QoL that is markedly lower than normative values in the general population. Sleep quality assessments further illustrate the difficulties faced by participants, showing a subjective sleep quality mean of 2.05 (SD=0.9), a sleep latency score of 1.74 (SD=0.7), and an average sleep duration of only 2.32 hours (SD=0.5), which is alarmingly below the recommended 7-9 hours for adults and can lead to various health complications (Hirshkowitz et al., 2015). Additionally, the sleep efficiency score of 2.12 (SD=0.6) and sleep disturbances score of 1.87 (SD=0.7) highlight significant issues with maintaining restful sleep, compounded by a mean score of 2.57 (SD=0.8) for sleeping medication use and a daytime dysfunction score of 1.75 (SD=0.6). Mental health indicators are equally concerning, with SDS mean of 54.05 (SD=6.82) and SAS mean of 52.45 (SD=3.60), suggesting high levels of depression and anxiety that can significantly affect rehabilitation outcomes and overall well-being (Kumar et al., 2016). The correlation between poor sleep quality and increased levels of depression and anxiety has been well-documented, indicating that addressing sleep issues may be crucial for improving mental health in this population [26, 27].

The correlation analysis reveals distinct relationships between QoL indicators and mental health measures in individuals with TSCI. The PCS-12 showed negligible association with the PSQI ($r=0.04$, $p=0.64$) and minimal association with the SDS ($r = 0.12$), indicating that physical health may not significantly influence sleep quality or depression levels. A moderate association with the SAS ($r=0.34$, $p=0.87$) suggests some relationship between physical health and anxiety, but it remains weak. In contrast, the MCS-12 demonstrated a significant positive association with the PSQI ($r=0.45$, $p=0.03$), highlighting that better mental health is associated with improved sleep quality this outcomes confirm with previous study [28]. However, the weak association with both the SDS ($r=0.24$, $p=0.85$) and SAS ($r=0.12$, $p=0.53$) indicate that the interplay between mental health, anxiety, and depression is complex. These findings emphasize the necessity for targeted interventions that simultaneously address mental health and sleep quality to enhance overall QoL for individuals with TSCI [6].

The analysis reveals significant impacts of injury characteristics, gender, and sleep disorders on QoL in individuals with spinal cord injuries. The level of injury negativley influenced both the PCS-12 ($\beta = 2.32$, $p = 0.031$) and the overall SF-12 score ($\beta = 12.37$, $p < 0.001$), while injury severity negatively affected the PCS-12 ($\beta = -4.26$, $p < 0.001$) without impacting the MCS-12. Gender positively influenced the PCS-12 ($\beta = 3.19$, $p = 0.021$) but had a borderline negative effect on the SF-12 ($\beta = -2.17$, $p = 0.05$). Sleep disorders, including SDB and insomnia, negatively affected the PCS-12 ($\beta = -5.42$, $p = 0.035$; $\beta = -4.25$, $p = 0.024$) while showing complex relationships with the overall SF-12 score ($\beta = 3.12$, $p = 0.017$; $\beta = 1.68$, $p = 0.039$). Periodic leg movements also

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DOI:10.26502/fjsrs0084

had negative effects on both measures (β = -6.14, p = 0.031; β = -9.74, p = 0.024). These findings highlight the complex interplay of these factors in influencing QoL, emphasizing the need for comprehensive management strategies.

The study's strengths include its comprehensive assessments using self-reported surveys, standardized questionnaires, and objective polysomnography, which enhance the reliability of findings. With a robust sample size of 100 participants, the research offers generalizable insights into sleep disorders among individuals with traumatic spinal cord injury (TSCI), a vulnerable population often overlooked in health studies. By identifying the prevalence of sleep disorders, the study underscores the scope of the issue and informs clinical practices, providing a foundation for developing targeted interventions to improve sleep quality and overall health outcomes for this group.

The limitations of the study encompass its cross-sectional design, which limits the capacity to determine causality between sleep disorders and quality of life outcomes. Dependence on self-reported data may introduce bias, as participants might underreport or exaggerate their sleep problems. Furthermore, the lack of longitudinal follow-up means the study may not reflect changes in sleep quality and health outcomes over time. Finally, the results may also lack generalizability due to differing demographic factors, such as age, gender, and injury severity among TSCI people.

Conclusion

This research highlights the notably impact of sleep disorders and sleep quality on the psychological well-being of individuals with TSCI. High prevalence of sleep issues, such as sleep-disordered breathing and insomnia, exacerbates physical and mental health challenges, resulting in notably low QoL scores. This study reveals complex relationships between injury characteristics, gender, and sleep disturbances, indicating that while physical health may not directly correlate with sleep quality, better mental health is associated with improved sleep. These findings underscore the requirement for comprehensive care strategies that tackle both sleep health and rehabilitation to enhance outcomes for TSCI people, focusing on the relevance of complete assessments and directed interventions.

Deceleration

Informed consent

All individual participants in the study provided informed consent.

Conflict of interest

The authors state that they have no conflicts of interest.

Funding: None

Ethical approval

All actions taken in studies with human participants complied with the ethical guidelines of the institutional and/or national research committee (Hubei University of Science and Technology, No. 2024-02-001) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Acknowledgements

The authors thank the Rehabilitation department for the cooperate.

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Citation: Ruba Altahla, Jamal Alshorman, Maria karaminasian, Somayeh Sadeghi, Mohammed Alnaggar. Impact of Sleep Disorders and Sleep Quality on Psychological Well-Being and Quality of Life in Patients with Traumatic Spinal Cord Injury. Journal of Spine Research and Surgery. 7 (2025): 26-32.