

# Sleep Disturbance Following Orthopaedic Trauma – Does it Predict Future Physical Functioning?

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## Purpose

Following trauma, patients experience a variety of psychologic and somatic symptoms, as well as poor long term functional outcomes. A number of psychosocial factors and symptoms, ranging from elevated pain and anxiety to low self efficacy and social support, have been found to be associated (and possibly causally related) to functional outcomes in this population. These factors are currently the subject of intense study, both as predictors and as targets for interventions.

While sleep disturbances appear to play a role in several trauma-related conditions, including Post Traumatic Stress Disorder (PTSD) and Traumatic Brain Injury (TBI), little is known about the association of sleep with functional outcomes after orthopaedic trauma. There are a number of possible theoretical pathways that make sleep a strong candidate for playing a causal role in disability following trauma. These pathways, summarized in Figure 1, include: (a) worsened TBI and PTSD symptoms; (b) increased pain symptoms, resulting in worsened anxiety, depression, and function; (c) the potential for delayed fracture healing due to poor sleep patterns; and (d) sleep-related immune function impairments resulting in increased complication risk. While some of these pathways are purely theoretical, in combination they suggest sleep is a worthwhile target for further study.

The goal of this analysis is to describe the extent and severity of sleep disturbances 3 and 6 months following orthopaedic injury and document the relationship between sleep disturbance at 3 months and subsequent physical function measured at 6 months.

Table 1

Patient Characteristics for Sample (n=777)

Patient Characteristics	Percent
Male	69.3
White	77.8
At Least HS Education	85.4
Multiple Injuries	77.7
Head Injury	9.2
Injury Severity (Based on Parent Study)	56.9
Mean Age (SD)	41.8 (13.4)

Figure 1

Theoretical Basis For Relationship Between Sleep and Physical Function

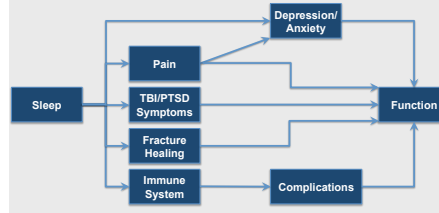


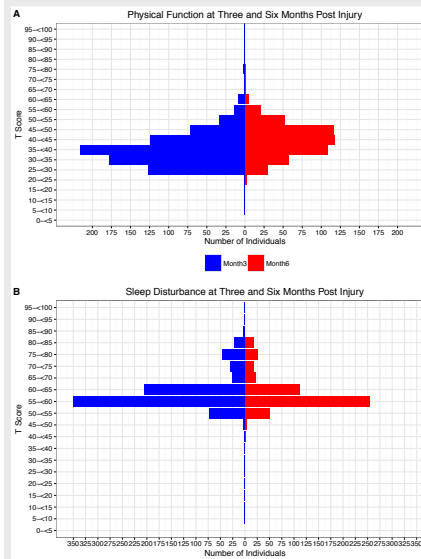
Table 2

Prediction of 6-Month Physical Function (n=482)

Parameter	Standardized Coefficient (95% Confidence Interval)	P-value
Baseline Sleep Disturbance	-0.240 (-2.437, -1.161)	0.000
Male	0.067 (-0.145, 1.198)	0.124
Age	-0.141 (-1.822, -0.421)	0.002
At Least HS Education	0.060 (-0.199, 1.157)	0.166
Injury Severity (Based on Parent Study)	-0.230 (-2.527, -1.130)	0.000
Baseline Physical Function	0.401 (2.602, 3.934)	0.000
Baseline Sleep Disturbance	-0.142 (-1.672, -0.467)	0.001
Male	0.064 (-0.106, 1.123)	0.105
Age	-0.086 (-1.333, -0.037)	0.038
At Least HS Education	0.086 (0.069, 1.314)	0.030
Injury Severity (Based on Parent Study)	-0.145 (-1.81, -0.501)	0.001

Figure 2

Distribution for Physical Function and Sleep Disturbance at 3-Month and 6-Month Follow Up



## Results

The mean Sleep score for this group was 55.8 (standard deviation: 7.3) at 3 months and 55.3 (standard deviation: 7.1) at 6 months. The mean PF score for this group was 32.1 (standard deviation: 8.0) at 3 months and 36.9 (standard deviation: 8.0) at 6 months, indicating significant physical function limitations in this population.

Thus, the mean Sleep scores were far closer to population means than the PF scores (see Figure 2). Among 89 participants (18% of the sample) who had 3-month Sleep scores more than one standard deviation above population norms, mean 6-month PF scores were 32.6 (standard deviation: 6.1), compared to 37.7 (standard deviation: 8.0) among the 396 participants with 3-month Sleep scores within one standard deviation of population norms (Student's t-test p-value <0.001).

After adjustment for demographics, severity, and PF at 3 months, a one-point increase in sleep disturbance at 3 months was associated with a 0.15 point decrease in PF at 6 months (95% Confidence Interval: -0.229, -0.064; p=0.001; see table 2).

## Conclusions

Despite a well-documented elevated prevalence of sleep disturbances in numerous other trauma populations, the prevalence in this broad orthopaedic trauma population was only moderately higher than population norms. However, there was a significant relationship between 3-month sleep disturbance and poorer 6-month physical function, suggesting that, as has been seen in other patient populations, poor sleep is associated with worse outcomes for orthopaedic trauma patients. The magnitude of the observed effect was modest, and it is unclear if it was clinically as well as statistically significant in this longitudinal dataset. While these data do not provide definitive evidence for sleep as a major driver of outcomes, it supports the need for further research to determine if interventions to improve sleep could improve the physical health of this population.

## Methods

A total of 777 orthopaedic trauma patients treated at academic trauma centers were interviewed at 3 months following an orthopaedic injury (including open and closed tibia, calcaneus, pilon, ankle and foot fractures, and below the knee amputees). Of these patients, 511 had also been followed up at 6 months post trauma. The NIH Patient Reported Outcomes Measurement Information System (PROMIS) framework is designed to improve measurement of patient reported outcomes with greater quality and precision while reducing respondent burden using Computer Adaptive Testing (CAT) techniques. PROMIS instrument scores are normalized to the general US population. Domains are scored on a 0 to 100 scale, standardized to a mean of 50 and a standard deviation of 10.

Participants were assessed using the PROMIS sleep disturbance (Sleep) and physical function (PF) domains at both 3 and 6 months. In the PROMIS PF scale, lower numbers indicate greater physical function limitations, while in the PROMIS Sleep scale, higher numbers indicate greater sleep disturbance. A multivariable linear regression analysis was conducted to estimate the relationship between Sleep at 3 months and PF at 6 months, as we would expect sleep disturbances to be manifest in an extended period of diminished function. Covariates included PF at 3 months, patient demographics (age, sex, race, and education) and injury characteristics (polytrauma, head AIS > 2, and Gustilo III open fractures (vs. lower severity injuries). Patient characteristics are shown in Table 1.

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- Additional information about METRC, including core funding can be found at [www.metrc.org](http://www.metrc.org)