The relationship between sleep, pain,and musculoskeletal injuries in US Army Soldiers

Bradley M Ritland ,[1] J L Judkins,[1] J A Naylor,[2] J R Kardouni,[3] S M Pasiakos,[1] J M Jayne[4]

[1]Military Performance Division, United States Army Research Institute of Environmental Medicine, Natick, Massachusetts, 01760, USA
[2]US Army Forces Command, Tacoma, Washington, 98433, USA
[3]US Army Forces Command, Fort Bragg, North Carolina, 28310, USA
[4]Military Nutrition Division, United States Army Research Institute of Environmental Medicine, Natick, Massachusetts, 01760, USA

Correspondence to
Dr Bradley M Ritland, Military Performance Division, United States Army Research Institute of Environmental Medicine, Natick, MA, 01760, USA; bradley.m.ritland.mil@health.mil

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ABSTRACT

Introduction The purpose of this study was to investigate the relationship between sleep and pain in military personnel and to determine if metrics of sleep and pain intensity differ between the injured and uninjured in this population.

Methods Active-duty US Army Soldiers (n=308; 26.8±6.5 years, 82% male) from the 2nd Infantry Division, Joint Base Lewis-McChord, Washington, and 101st Airborne Division, Fort Campbell, Kentucky, completed the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and questionnaires about current musculoskeletal injuries and pain intensity (0=no pain to 10=worst imaginable pain). Pearson correlation coefficients were used to assess the association between pain and sleep. Differences in sleep and pain between injured and uninjured participants were determined using an analysis of covariance.

Results Pain intensity was positively correlated with sleep quality (global PSQI score, r=0.337, p<0.001) and daytime sleepiness (ESS score, r=0.163, p=0.005), and negatively associated with sleep duration (r=−0.118, p=0.039). Injured participants accounted for 37.7% (n=116) of the study population. Injured participants reported greater pain intensity (3.7±2.5 vs 1.3±1.9, p<0.001), were older (28.5±7.4 years vs 25.8±5.7 years, p=0.001) and in the service longer (6.3±6.3 years vs 4.6±4.7 years, p=0.013) than uninjured participants. Injured participants had higher global PSQI scores (9.0±4.1 vs 6.4±3.4, p<0.001), including each of the seven PSQI components (all p<0.050), and reported sleeping less per night than uninjured participants (5.7±1.3 hours vs 6.1±1.2 hours, p=0.026).

Conclusion These data demonstrate that pain intensity is associated with sleep in active-duty US Army Soldiers and that those who report a musculoskeletal injury, regardless of age and time in service, report poorer sleep quality, shorter sleep durations, and greater levels of pain than uninjured Soldiers.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Musculoskeletal injuries and insufficient sleep commonly occur in military personnel.
⇒ The relationship between sleep and injuries, as well as sleep and pain, in military populations is understudied.

WHAT THIS STUDY ADDS

⇒ Pain was associated with sleep (duration, quality, daytime sleepiness) in this cohort and injured Soldiers reported poorer sleep quality and shorter sleep durations than uninjured Soldiers.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ When managing military personnel with sleep issues, pain and/or musculoskeletal injuries, treatment strategies should be cognisant of the observed relationship between the three.
⇒ Policies should aim to optimise sleep quality and duration in military populations when the mission permits.

INTRODUCTION

Military personnel often report sleeping less than 7 hours per night (ie, inadequate sleep) throughout their careers,[1 2] which can degrade physical and cognitive performance.[3 4] As a result, military leaders are encouraged to incorporate sleep and fatigue management into operation planning and execution.[5] Evidence from research in civilians suggests inadequate sleep in younger athletes[6] increases musculoskeletal injury risk; however, in adult athletes more studies are needed to establish whether this relationship exists.[7] Similarly, the potential link between sleep and musculoskeletal injury risk in military personnel is not well described. Inadequate sleep was inversely associated with injury risk in Army Special Operations Forces (SOF) personnel[8] and injured male Army Rangers report poorer sleep quality than uninjured Rangers.[9] Outside of these populations, and despite nearly 50% of the active-duty Army population reporting a musculoskeletal injury in a single year,[10] the association between sleep and injury has not been established in a broad representative sample of military personnel.

Pain during a functional movement screen may predict musculoskeletal injury in military personnel,[11] which is concerning considering that pain is a common issue with as much as half of infantry Soldiers returning from deployment report experiencing chronic pain.[12] While pain and injury routinely coincide, there is also a bidirectional relationship between pain and sleep in civilians,[13] with sleep impairments being more predictive of pain than pain is of sleep impairments.[14] Currently, the relationship between sleep and pain in military personnel is undetermined, which may limit the efficacy of interventions aimed at managing pain or sleep issues.

The purpose of this study was to explore the relationship between sleep and pain in military personnel and to determine if metrics of sleep and

pain intensity differ between the injured and uninjured in this population. It was hypothesised that pain intensity would be positively associated with daytime sleepiness and sleep quality (high scores equate to poor sleep quality), and negatively correlated with sleep duration. It was also expected that injured personnel would report shorter sleep duration, worse sleep quality, and higher daytime sleepiness than uninjured personnel.

METHODS

Data in this study were collected during the conduction of a larger ongoing study investigating the health and performance effects on active-duty Soldiers of the recent US Army Holistic Health and Fitness (H2F) initiative, a large-scale health promotion initiative aimed at improving the way the Army trains and cares for Soldiers, during the first 2 years of a unit receiving H2F resources (ie, additional performance/health personnel). The data presented herein were derived from the initial baseline time point of that study.

Active-duty US Army Soldiers from the 2nd Infantry Division, Joint Base Lewis-McChord, Washington, and 101st Airborne Division, Fort Campbell, Kentucky, participated in this study and completed the Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), and questionnaires about current musculoskeletal injuries and pain levels. The PSQI is a validated 19-item questionnaire designed to evaluate self-reported sleep quality and disturbances in adults over the past 30 days.[15] The PSQI responses are grouped to assess seven component factors, including subjective sleep quality (component 1), sleep latency (component 2), sleep duration (component 3), sleep efficiency (component 4), sleep disturbances (component 5), sleep medication use (component 6), and daytime dysfunction (component 7). Each component score is weighted equally, with scores ranging from 0 to 3 (higher scores indicating a worse score). The global PSQI score, which can range from 0 to 21, is the sum of the seven components and is an indicator of overall sleep quality. The ESS is a simple and reliable method for measuring daytime sleepiness in adults via eight questions measuring sleep propensity, with higher scores reflecting greater sleepiness (score range is 0–24).[16 17] To quantify injury rates, Soldiers were asked whether they had any *current* musculoskeletal injuries (yes or no). Pain intensity was acquired using an 11-point Likert scale that ranged from 0 (no pain) to 10 (worst imaginable pain).

Means and SDs were calculated for each outcome measure and Pearson correlation coefficients were used to explore associations between pain and sleep for all participants. An exploratory analysis of variance demonstrated that injured participants were older (28.5±7.4 years vs 25.8±5.7 years, p=0.001) and served in the Army longer (6.3±6.3 years vs 4.6±4.7 years, p=0.013) than uninjured participants. As such, an analysis of covariance was then used to re-examine potential differences between injured and uninjured participants adjusting for age and time in service. Statistical analyses were performed using SPSS V.26.0 (SPSS) and p values <0.050 were considered statistically different.

RESULTS

A total of 376 active-duty US Army Soldiers completed the study, but 68 were excluded from the analysis because they did not complete the questionnaires appropriately (ie, incomplete/no responses to questions), so the analyses focused on the remaining 308 participants (26.8±6.5 years; Table 1). Average nightly sleep duration for all participants was 5.9±1.3 hours, with only 24.4% reporting sleeping 7 hours or more (Table 2). Pain levels were significantly associated with the global PSQI score, all seven PSQI component scores, average sleep duration and the ESS score (all p<0.050; Table 3). Reported musculoskeletal injury prevalence was 37.7% (n=116). The global PSQI score, all seven PSQI component scores, average sleep duration and pain levels differed between injured and uninjured participants (all p<0.050; Table 4) after adjusting for age and time in service. No differences between injured and uninjured participants were observed for ESS scores.

Table 1 Demographic information

	All soldiers	Reported injury	No reported injury
Participants (n)	308	116	192
Age (years)	26.8±6.5	28.5±7.4	25.8±5.7*
Sex, male (%)	254 (82.5)	88 (75.9)	166 (86.5)
Sex, female (%)	54 (17.5)	28 (24.1)	26 (13.5)
Weight (kg)	81.1±14.5	82.8±15.5	80.1±13.9
Height (inches)	68.1±14.0	67.5±16.1	68.5±12.7
Racial background (%)			
African American/ Black	72 (23.4)	30 (25.9)	42 (21.9)
Asian	12 (3.9)	5 (4.3)	7 (3.6)
Caucasian/White	180 (58.4)	64 (55.2)	116 (60.4)
Native American/ Alaskan Native	3 (1.0)	3 (2.6)	0 (0.0)
Pacific Islander	9 (2.9)	2 (1.7)	7 (3.6)
Other/missing	32 (10.4)	12 (10.3)	20 (10.4)
Rank (%)			
Enlisted (E2–E9)	259 (84.1)	97 (83.6)	162 (84.4)
Officer (O1–O5)	38 (12.3)	11 (9.5)	27 (14.1)
Warrant officer	11 (3.6)	8 (6.9)	3 (1.6)
Time in service (years)	5.2±5.4	6.3±6.3	4.6±4.7*

Age, weight, height and time in service are mean±SD. Sex, racial background and rank are frequencies (%).
*P<0.050.

DISCUSSION

In this cohort of active-duty US Army Soldiers, pain intensity was associated with daytime sleepiness and sleep (quality and duration), more than one-third of the studied population reported a musculoskeletal injury, and injured Soldiers reported poorer sleep quality, shorter sleep durations and greater levels of pain than uninjured Soldiers. While pain has been associated with disturbed or poor sleep[13] and with sleepiness in civilians,[18] this is the first study to report these relationships in military personnel. Sleep quality (higher scores indicating worse sleep quality) and daytime sleepiness were positively associated with pain, while sleep duration was negatively associated with pain.

Table 2 Frequency (percentage) of participants who reported averaging nightly sleep durations within each category

Sleep duration (hours)	All soldiers (%)	Reported injury (%)	No reported injury (%)
<4	12 (3.9)	7 (6.0)	5 (2.6)
≥4 to <5	29 (9.4)	16 (13.8)	13 (6.8)
≥5 to <6	72 (23.4)	29 (25.0)	43 (22.4)
≥6 to <7	120 (39.0)	41 (35.3)	79 (41.1)
≥7 to <8	49 (15.9)	17 (14.7)	32 (16.7)
≥8 to 9	26 (8.4)	6 (5.2)	20 (10.4)

Table 3 Correlations between pain levels and sleep for all participants (n=308)

Outcome measure	Pain level (r value)	P value
Global PSQI score	0.337	<0.001
C1: sleep quality	0.316	<0.001
C2: sleep latency	0.213	<0.001
C3: sleep duration	0.143	0.012
C4: sleep efficiency	0.133	0.020
C5: sleep disturbance	0.330	<0.001
C6: sleep medication use	0.171	0.003
C7: daytime dysfunction	0.196	0.001
Sleep duration (hours)	−0.118	0.039
Epworth Sleepiness Scale	0.163	0.005

C, component; PSQI, Pittsburgh Sleep Quality Index.

All seven components of the PSQI were associated with pain indicating a consistent relationship, even though the strength of each relationship was moderate to weak (coefficient values were all below 0.35). Considering these associations do not imply that one causes the other, further evaluation is needed into whether strategies aimed at decreasing pain levels have any subsequent impact on sleep and whether improving sleep has an impact on pain levels in this population.

This study found that both sleep quality and sleep duration differ between injured and uninjured active-duty Army Soldiers. The global PSQI scores for the injured and uninjured Soldiers were both higher than 5, which is a score often used to distinguish good and poor sleepers.[15] This finding provides further evidence of sleep quality issues among military personnel. Injured male Army Rangers also report poor sleep quality [9] and poor sleep quality has been associated with injuries in some civilian populations.[19] The current study findings that injured Army Soldiers report shorter sleep durations (approximately 25 min less in this study) than uninjured Army Soldiers are consistent with what has been observed in SOF personnel[8] and Navy personnel.[20] The inverse relationship between sleep duration and injury risk has also been observed in young athletes.[21] The average sleep duration reported by those in this study (~6 hours) is consistent with what has been documented in other military populations,[22 23] with only one in four obtaining the recommended 7 hours or more of sleep per night.[24] Collectively, these findings highlight the need for Soldiers to prioritise nightly sleep durations. Daytime sleepiness did not differ between injured and uninjured Soldiers in the current study, which is consistent with what has been observed in Rangers[9] but contrasts to what has been observed in Navy personnel.[20]

Table 4 Mean scores in each outcome measure and the comparison of soldiers reporting injury versus not reporting an injury

Outcome measure	All soldiers	Injured	Uninjured	P value
Global PSQI score	7.4±3.9	9.0±4.1	6.4±3.4	<0.001
C1: sleep quality	1.4±0.8	1.7±0.8	1.2±0.7	<0.001
C2: sleep latency	1.3±1.0	1.7±1.1	1.1±1.0	<0.001
C3: sleep duration	1.3±1.0	1.4±1.0	1.1±0.9	0.031
C4: sleep efficiency	0.7±1.0	0.9±1.1	0.6±0.9	0.023
C5: sleep disturbance	1.2±0.7	1.4±0.6	1.1±0.6	0.001
C6: sleep medication use	0.5±1.0	0.7±1.1	0.3±0.8	0.004
C7: daytime dysfunction	1.0±1.0	1.2±1.0	0.9±0.9	0.009
Sleep duration (hours)	5.9±1.3	5.7±1.3	6.1±1.2	0.026
Epworth Sleepiness Scale	8.2±5.1	8.7±5.5	7.8±4.8	0.147
Pain level (0–10)	2.2±2.4	3.7±2.5	1.3±1.9	<0.001

Mean±SD. Between-group differences after conducting an analysis of covariance (ANCOVA), controlling for age and time in service.
C, component; PSQI, Pittsburgh Sleep Quality Index.

The prevalence of injured Soldiers in the current study (38%) was lower than what has been reported previously in military personnel (>50%).[8 10 20] Direct comparisons are challenging because the mentioned studies asked whether participants sustained an injury over the preceding 12 months, whereas the current study asked participants if they had any current injury at the time of completing the questionnaire. The aforementioned Ranger study[9] asked the same injury question as the current study and reported an injury rate of 15%; however, that study only included males, who are less susceptible to musculoskeletal injuries in the military than females.[11] The Soldiers who reported an injury were older, had more time in active service and reported pain levels close to three times the level reported by uninjured Soldiers, which is consistent with reviews that found age[25] and pain during a functional movement screen[11] are associated with an increased risk of injury in the military.

Considering the significant health problem musculoskeletal injuries are to military personnel[26] and the negative consequences associated with these injuries, such as limited duty days, increased medical costs, decreased deployability rates and secondary heath deficits,[27] it is encouraging to find that sleep may be a modifiable risk factor. Proper screening for sleep issues and sleep education is essential in order optimise sleep in athletes,[28] and the same should be the case for the military. Educating military leaders on the importance of sleep is one potential way to improve the sleep health in military personnel with minimal logistical burden.[29] While sleep interventions, such as sleep extension (sleeping longer than habitual amounts when not achieving optimal amounts), appear to confer performance and motivational benefits in military cadets in training,[30] they have yet to demonstrate an ability to attenuate injury risk. Future research should use longitudinal designs to evaluate whether strategies that improve sleep duration and quality in military personnel have any subsequent impact on injury or pain.

While the findings from this study are generalisable to Army personnel considering the inclusion of a diverse sample of Soldiers, including 18% women, across two large geographically dispersed locations, this study had limitations. The cross-sectional design did not allow for determinations of causality in the relationships between sleep, pain and injury. Future research should incorporate objective sleep measures (ie, actigraphy or polysomnography) and consider reviewing the medical records of the Soldiers to ascertain the injuries that Soldiers sought medical care for.

CONCLUSION

These data demonstrate that pain intensity is associated with sleep in active-duty Army Soldiers and that those who report a musculoskeletal injury, regardless of age and time in service, report poorer sleep quality, shorter sleep durations and greater levels of pain than uninjured Soldiers. Future research should investigate whether improving sleep has any subsequent impact on pain and injury rates in the military population.

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ORCID iD
Bradley M Ritland http://orcid.org/0000-0003-4559-6023

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